FINAL REPORT

In Situ Wetland Restoration Demonstration

ESTCP Project ER-200825

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reactive treatment, composite particle system, agglomerated amendment pellets, engineered blended amendments

14. ABSTRACT

This Final Report describes the details of Environmental Security Technology Certification Program Project ER-200825: In Situ Wetland Restoration Demonstration. The overall objective was to field demonstrate and validate activated carbon (AC) in situ wetland remediation technologies which have been designed to sequester contaminants in wetlands without adversely impacting system ecology. The Field Demonstration was performed at Canal Creek, Aberdeen Proving Ground (APG), Aberdeen, Maryland. This report includes discussion of quantitative and qualitative performance objectives, information about the study area, pre-demonstration testing, and the implementation and monitoring of the demonstration. Performance assessment criteria and methods, evaluation of the demonstration results, cost, potential implementation issues, and uncertainties associated with these findings are also discussed. The field demonstration was designed to evaluate three potential AC remediation technologies: two pelletized AC products, a powder AC slurry, and an engineered manufactured soil cover system. The efficacy to treat hydric soils impacted by polychlorinated biphenyls (PCBs) was assessed via analyses of PCB pore water and tissue residue concentrations. The partitioning of PCBs from soil-to-pore water and from soil-to-benthic tissue was also evaluated. The uptake of nutrients by plants was measured for each of the treatment types.

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sediment, wetlands, hydric soils, activated carbon, organoclays, pore water, PCBs, sequestration, bioavailability, toxicity testing

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Contents

Appendices

List of Tables

List of Figures

List of Acronyms

AC	Activated Carbon
AFB	Air Force Base
AFCEE	Air Force Center for Environmental Excellence
ANOVA	Analysis of Variance
APG	Aberdeen Proving Ground
ASE	Accelerated Solvent Extraction
ASTM	American Society for Testing and Materials
BAZ	Biologically Active Zone
BC	Black Carbon
BSAF	Biota Sediment Accumulation Factor
CAS	Columbia Analytical Services, Inc.
CCSA	Canal Creek Study Area
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
COC	Contaminant of Concern
COPC	Chemical of Potential Concern
CWA	Clean Water Act
CWMDP	Chemical Warfare Material Degradation Product
DDD	Dichloro-Diphenyl-Dichloroethane
DDE	Dichloro-Diphenyl-Dichloroethylene
DDT	Dichloro-Diphenyl-Trichloroethane
DDx	Total DDT, i.e. the sum of DDT, DDE, and DDD
DI	Deionized
DoD	Department of Defense
DON	Department of Navy
ENR	Enhanced Natural Recovery
EMNR	Enhanced Monitored Natural Recovery
ERDC WES	Engineer Research and Development Center Waterways Experiment Station
ESTCP	Environmental Security Technology Certification Program
FAA	Federal Aviation Administration
GC/ECD	Gas Chromatogaphy/Electron Capture Detection
GC/MS	Gas Chromatography /Mass Spectrometry
GPS	Global Positioning Systems
HA	Hectare
HASP	Health and Safety Plan
HOCs	Hydrophobic Organic Contaminants
HVW	High Value Wetland
IDW	Investigation Derived Waste
ITRC	Interstate Technology and Regulatory Council
lbcph	Pounds Carbon Per Hour
lft	Linear Feet
LVW	Low Value Wetland
MDE	Maryland Department of Environment
ml	Milliliter

μL	Microliter
MNR	Monitored Natural Recovery
MRP	Munitions Response Program
MWMA	Maryland Wildlife Management Area
NA	Not Applicable
NAS	National Academy of Sciences
NAVFAC ESC	Naval Facilities Engineering Command Engineering Service Center
NAVFAC EXWC	Naval Facilities Engineering and Expeditionary Warfare Center
NAVFAC LANT	Naval Facilities Engineering Command Atlantic Division
NOAA	National Oceanographic and Atmospheric Administration
NOC	Natural Organic Carbon
NRCS	National Resources Conservation Service
NWCA	National Wetland Condition Assessment
OC	Organoclay
OSWER	Office of Solid Waste and Emergency Response
PAC	Powdered Activated Carbon
PBT	Persistent, Bioaccumulative, and Toxic
PCB	Polychlorinated Biphenyl
PE	Polyethylene
PED	Polyethylene Device
POM	Polyoxymethylene
PPE	Personal Protection Equipment
psi	Pounds per Square Inch
QA	Quality Assurance
QC	Quality Control
RBP	Rapid Bioassessment Protocol
RO	Reverse Osmosis
SETAC	Society of Environmental Toxicology And Chemistry
SPME	Solid Phase Microextraction
TBC	To Be Considered
TLC	Thin Layer Cap
TOC	Total Organic Carbon
UNH	University of New Hampshire
USACE	United States Army Corps of Engineers
USACHPPM	U.S. Army Center for Health Promotion and Preventive Medicine
USEPA	United States Environmental Protection Agency
USFWS	United States Fish and Wildlife Service
USGS	United States Geological Survey
UXO	Unexploded Ordinance
VOA	Volatile Organic Analysis
WAA	Watershed Assessment Associates
WQS	Water Quality Standard
ZVI	Zero-Valent Iron

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The Department of Defense (DoD) Environmental Security Technology Certification Program (ESTCP) has funded the Naval Facilities Engineering and Expeditionary Warfare Center (NAVFAC EXWC) and its DoD partners: U.S. Army Public Health Command, Naval Facilities Engineering Command Atlantic Division (NAVFAC LANT), U.S. Air Force (USAF), and Engineer Research and Development Center Waterways Experiment Station (ERDC WES) to conduct work under ESTPC Project No. ER-2000825. AECOM and the University of New Hampshire (UNH) were also funded by ESTCP to perform this demonstration project. The work would not have been possible without the cooperation and support from many individuals at the U.S. Army's Aberdeen Proving Ground.

Executive Summary

This Final Report has been prepared to describe the details of Environmental Security Technology Certification Program Project ER-200825: *In Situ* Wetland Restoration Demonstration. The overall objective of ESTCP Project ER-200825 was to field demonstrate and validate activated carbon (AC) *in situ* wetland remediation technologies which have been designed to sequester contaminants in wetlands without adversely impacting the ecology of these systems. The Field Demonstration was performed at Canal Creek, Aberdeen Proving Ground (APG), Aberdeen, Maryland. The Final Report includes discussion of quantitative and qualitative performance objectives, information about the Canal Creek Study Area, pre-demonstration testing, and activities associated with the implementation and monitoring of the demonstration. Performance assessment criteria and methods, evaluation of the demonstration results, cost, potential implementation issues, and uncertainties associated with these findings are also discussed.

Remediation of wetlands soils impacted by contamination present unique challenges due to the desire to preserve hydric soil structure and the presence of sensitive ecological receptors. Traditional active remediation technologies of removal and off-site disposal can destroy habitat and create challenging restoration conditions, the costs of which may equal the cost of remediation. This project demonstrates a less aggressive, more sustainable, and cost-effective remediation approach than physical removal and off-site disposal.

To this end, the field demonstration was designed to monitor the performance of three potential activated carbon remediation technologies: two pelletized AC products (AquaBlok® and SediMite™), a powder AC slurry (referred to as the Slurry Spray), and an engineered manufactured soil cover system (referred to as the Sand control) were tested. Untreated control plots (Control) were also used in the demonstration for comparative purposes. The efficacy of the technologies to treat hydric soils impacted by polychlorinated biphenyls (PCBs) was assessed via evaluations of PCB pore water and tissue residue concentrations (pre- and post-treatment, and relative to control plots). In addition, due in large part to small sample sizes and a high degree of heterogeneity in PCB concentrations in the treatment plots, the partitioning of PCBs from soil-to-pore water and from soil-to-benthic tissue was also evaluated. Concentrations of PCBs were measured in bulk hydric soil[1], pore water, and benthic receptor tissue in the laboratory, from collected soil samples, for the partitioning (bioavailability/bioaccumulation) assessment. Ecological monitoring was conducted in the laboratory and the field to assess whether the treatment technologies created deleterious effects or if treatment caused conditions to remain unchanged or improved for wetlands vegetation and benthos. The uptake of nutrients by plants was also measured for each of the treatment types. Depending on the metric, either statistical differences or relative differences between baseline monitoring and post-treatment monitoring were determined.

The outcomes of the demonstration project indicate that additional monitoring may be necessary to demonstrate that *in situ* active remediation by activated carbon can be effective in sequestering hydrophobic organic compounds in contaminated wetland sediments. While the findings of the

[1] The term "hydric soils" is principally used throughout this document. In cases where the term "sediment" is used in this report, or in the final report for ER-200835, the terms are considered here as synonymous.

overall program suggest that additions of activated carbon can sequester PCBs, the field demonstration findings were not conclusive in demonstrating effective reductions in bioavailability. The reader is cautioned that field conditions in this demonstration project were not controlled as in a laboratory setting. Confounding issues associated with the field monitoring program included the wide PCB heterogeneity in the field, small sample sizes, the short period of post-application monitoring, the unexpectedly slow mixing of the placed carbon with the underlying contaminated sediments, as well as the overall-design of the sampling and monitoring program to measure PCB sequestration *in situ*. An additional potential confounding factor is that black carbon was present in the system prior to treatment application and that migration of placed carbon into or out of the treatment area may have occurred; these factors also potentially impacted the demonstration of treatment efficacy.

The overall program results do suggest that the active *in situ* remediation technologies tested in this project could be effective for the remediation of contaminated wetland sediments. Bench-scale testing of the activated carbon treatments during the treatability study confirmed PCB sequestration. Equipment to deploy the amendment products was readily available, and was demonstrated to be easily adapted to the task, resulting in effective placement of all activated carbon products over the treatment plots. However, an important finding is that cold weather may limit the degree to which high moisture products may be deployed successfully.

The findings of this project are not sufficient to warrant a general recommendation that this technology is readily applicable as a remedial technology for PCBs in wetland sediments. While the overall results are encouraging, additional field monitoring would be necessary to demonstrate the efficacy of using activated carbon. If sequestration can be demonstrated, application of amendments as a remedial technology may be well suited to applications in beneficial habitats such as wetlands where habitat disruption should be minimized; where desirable wildlife might be harmed by traditional remedial methods such as dredging; where hydric soils pose a remediable risk and the cost of excavation or dredging and disposal exceed the level of risk but risk reduction is desired; access the wetland system (e.g., infrastructure improvements) to deliver sequestration agents are not cost-prohibitive; and long-term monitoring requirements are not cost-prohibitive.

A general summary of the project's technical outcomes follows.

Treatability and Application Studies

- Bench-scale laboratory studies demonstrated that all activated carbon products were effective in sequestering PCBs; rendering those biologically unavailable to uptake by benthic organisms.
- The methods developed for field application of activated carbon were highly effective, resulting in relatively uniform distribution of the placed amendment at the targeted levels.

Site Characterization

- Bulk hydric soil concentrations were heterogeneous within the study area, both prior to and following treatment. Concentrations ranged over two orders of magnitude and were typically higher post treatment.

- Applied activated carbon was not mixed into the underlying contaminated sediments to the degree expected in the field applications. Post-application core samples showed that the bulk of applied amendment was generally found in the upper 2 to 5 cm of the sediment column. This meant that in taking 6-inch depth (i.e., 15 cm) samples for laboratory analyses most, if not all of the applied black carbon, was in the tested samples. This likely affected the pore water and *Lumbriculus variegatus* tissue uptake measures, and the subsequent partitioning calculations.
- Pore water concentrations were similarly heterogeneous and ranged over several orders of magnitude prior to and following treatment. Pore water concentrations generally increased with depth. With the exception of AquaBlok®, pore water concentrations were generally not statistically significantly different following treatment.
- Benthic tissue concentrations measured in *L. variegatus* were also heterogeneous and ranged over several orders of magnitude. Concentrations, while typically lower following treatment, were generally not statistically different when post-treatment data were compared to pre-treatment concentrations. However, the AquaBlok® post-treatment tissue concentrations were statistically significantly lower than the pre-treatment concentrations.

Black carbon was present in the wetlands hydric soil prior to treatment in variable percentages across the study area. Percent black carbon was highly variable after treatment, with standard deviations upward of 2 percent on average in some cases.

Pore Water and Tissue Residue Evaluation

A general decrease in average total PCB pore water concentration was observed following treatment within the Slurry Spray and AquaBlok® treatment plots. Pore water concentrations, except for AquaBlok®, were not statistically significantly different between pre- and post-treatment. However, AquaBlok® and Slurry Spray post-treatment pore water concentrations were statistically significantly lower than the post-treatment Control plots. The temporal and spatial heterogeneity of PCBs measured in bulk sediment and a sample depth that exceeded designed treatment depth may explain why reductions in pore water concentrations were not more clearly definitive as to the effectiveness of treatment as interpreted by reductions in pore water concentrations in this study.

Lumbriculus receptor tissue concentrations were statistically significantly lower in AquaBlok® post-treatment compared to pre-treatment concentrations. *Lumbriculus* receptor tissue concentrations in the Slurry Spray and Sand control were arithmetically lower, but not statistically different when post-treatment data were compared to pre-treatment data. However, AquaBlok® and Slurry Spray post-treatment *Lumbriculus* receptor tissue concentrations were statistically significantly lower than the post-treatment Control plots. Post-treatment tissue concentrations in the SediMite™ and Sand Control treatments were also arithmetically lower than the post-treatment Control.

Partitioning Evaluation

Measurements of bulk hydric soil, pore water, and tissue concentrations are the metrics required to demonstrate reductions of environmental risk of exposure to PCBs. Ideally, reductions in pore water concentrations would be a preferred metric for evaluation of treatment efficacy. Given that those metrics did not provide a clear demonstration of effectiveness, an alternative line-of-evidence was to assess the partitioning of PCBs between soil and pore water and relative uptake in benthic macroinvertebrate tissue. The pore water to solid bulk phase partitioning coefficient ($K_{bulk/pw}$), referred to within this report simply as the pore water partitioning coefficient, is defined as the ratio of the bulk phase concentration divided by the pore water phase concentration. An increase in partitioning represents a shift from the pore water phase to the bulk phase and a reduction in bioavailability (i.e., enhanced treatment). The *Lumbriculus* tissue to solid phase partitioning coefficient ($K_{bulk/Lv}$), or the *Lumbriculus* partitioning coefficient, is the ratio of the bulk phase concentration to the *L. variegatus* tissue concentration. Both of these partitioning coefficient metrics are discussed in detail in the main body of the report. Both $K_{bulk/pw}$ and $K_{bulk/Lv}$ were normalized to pre-treatment portioning coefficients to evaluate the data relative to baseline conditions and to evaluate treatment effectiveness.

Enhanced treatment is indicated for both the pelletized (AquaBlok® and SediMite™) and slurry (Slurry Spray) sequestration agents because partitioning to the bulk phase from the pore water phase increased between the pre-treatment and post-treatment sampling events (within population pre- and post-treatment comparison), as evidenced by an increase in the mean pore water partitioning coefficient. An increase between the pre- and post-treatment mean $K_{bulk/pw}$ was also observed within the Control and a statistically insignificant decrease was observed in the Sand control. A statistical comparison of treatment $K_{bulk/pw}$ against the Control $K_{bulk/pw}$ (pooled post-treatment populations comparison to the Control pooled post-treatment population) showed statistically significant increases in $K_{bulk/pw}$ for one pelletized AC product (AquaBlok®). A second pelletized AC product (SediMite™), the Slurry Spray, and the Sand control were not determined to be statistically different from the Control.

Partitioning to the bulk phase between the pre-treatment and post-treatment was observed for all treatments and control plots, as evidenced by an increase in the mean *Lumbriculus* partitioning coefficient, $K_{bulk/Lv}$. A statistical evaluation between the baseline and post-treatment periods determined a statistically significant increase in $K_{bulk/Lv}$ for AquaBlok®, Slurry Spray, Sand control, and the Control. SediMite™ was excluded from this evaluation because baseline sampling was not conducted (although the Time 1 and Time 2 measurements indicate a non-statistically significant increase in the $K_{bulk/Lv}$ over time). A second statistical evaluation compared the post-treatment Control to the treatment plots post-treatment. Statistically increased $K_{bulk/Lv}$ values were observed for the AquaBlok® and Slurry Spray relative to the Control. No significant variance was observed for SediMite™ or the Sand control.

Vegetation Survey

Vegetation survey, plant biological, toxicological, and nutrient uptake metrics, and benthic macroinvertebrate survey were used to evaluate the ecological effects of AC treatment. Ecological results are as follows:

- 49 species recorded in wetland / 32 total species recorded in plots
- Up to 19 species within a single plot
- Common reed >90% in some plots
- No gross effects due to treatment application (early senescence, yellowing, stunting observed)
- No statistically significant differences between treatment and control plots in relative vegetation cover.
- No statistically significant differences between treatment and control plots in species richness or diversity.

Plant Biological, Toxicological and Nutrient Metrics

- No adverse effects in survival, shoot weight (wet and dry), or shoot length due to treatment.

Nutrient uptake measured as the ratio of nutrient concentration in plant to concentration in soil was typically not statistically significantly different from the untreated site Control (Table 1).

Table 1 Nutrient Uptake

Treatment	B	Ca	Cu	Fe	Mg	Mn	P	K	Na	S	Zn	N
Slurry Spray (APG-02)	↑	↑	↑	---	↑	↑	↑	↑	---	---	↑	↑
AquaBlok® (APG-06)	↑	---	↑	---	↑	---	↑	↑	---	---	↑	↑
SediMite™ (APG-16)	---	↑	---	---	↑	---	---	---	---	↓	---	---

Note: (“—“) to increased nutrient uptake on average (↑ or ↓).

Benthic Macroinvertebrate Survey

A paucity of organisms in the wetland prevent drawing conclusions as to the effects of treatment based on the benthic macroinvertebrate population.

1.0 INTRODUCTION

The Department of Defense (DoD) Environmental Security Technology Certification Program (ESTCP) has funded the Naval Facilities Engineering and Expeditionary Warfare Center (NAVFAC EXWC, formerly Naval Facilities Engineering Command Engineering Service Center [NAVFAC ESC]) and its DoD partners U.S. Army Public Health Command (formerly the U.S Army Center for Health Promotion and Preventive Medicine [USACHPPM]), Naval Facilities Engineering Command Atlantic Division (NAVFAC LANT), Air Force Center for Engineering and the Environment (AFCEE), and Engineer Research and Development Center Waterways Experiment Station (ERDC WES) as well as their contractors AECOM Corporation and the University of New Hampshire (UNH), to demonstrate and validate an innovative technology for the *in situ* sequestration of contaminants present in hydric soils of palustrine wetlands (ESTCP Project ER-200825: *In Situ* Wetland Restoration Demonstration).

This Final Report has been prepared to describe the detailed field demonstration including performance objectives, site information, pre-demonstration testing, and activities associated with the actual demonstration. Performance assessment criteria and methods, evaluation of the demonstration results, cost, and potential implementation issues are also discussed.

The Field Demonstration was performed at Canal Creek, U.S. Army Aberdeen Proving Ground (APG), Aberdeen, Maryland (Figure 1-1). The Canal Creek site is also being used by another ESTCP-funded project team (ER-200835: Evaluating the Efficacy of a Low-Impact Delivery System for *In Situ* Treatment of Sediments Contaminated with Methylmercury and Other Hydrophobic Chemicals). Per ESTCP request, the two project teams have been in routine communication, have conducted joint strategy sessions, and have staffed field work to date with representatives from both project teams.

Figure 1-1 Native Hibiscus in Canal Creek Study Area

1.1 BACKGROUND

Wetlands owned by the DoD often act as sinks for contaminants including persistent, bioaccumulative, and toxic (PBT) compounds (e.g., Polychlorinated Biphenyls [PCBs], Dichloro-Diphenyl-Trichloroethane [DDT] and its breakdown products, Dichloro-Diphenyl-Dichloroethane [DDD] and Dichloro-Diphenyl-Dichloroethylene [DDE]; here-in-after referred to as “DDx” for all three compounds combined), as well as inorganic constituents (e.g., copper and lead) and energetics from firing range operations. Federal and state agencies routinely mandate that the DoD and other responsible parties conduct remedial actions to address contamination in wetlands. As a result, the Army, Navy, and Air Force have millions of dollars of potential cleanup liabilities associated with contaminated wetlands (Pound, 2012). In addition, treatment wetlands designed to serve as polishing mechanisms for stormwater runoff are also increasingly being utilized and may require remediation if overloaded. The Navy has more than 200 contaminated sediment sites with projected remediation cost of $1.3 billion; Munitions Response Program (MRP) sites add another

$1 billion of potential liability. The United States Environmental Protection Agency (USEPA) is currently conducting a National Wetland Condition Assessment (NWCA), which will provide the first-ever regional and national estimates of wetland ecological integrity and rank the stressors most commonly associated with impaired conditions. The final report is anticipated for release at the end of 2013. In addition to efforts by DoD and USEPA to catalog and understand the impacts of contamination on wetlands quality, the Federal Aviation Administration (FAA) is interested because airports are also recognized as having significant contaminated wetlands liabilities (National Academy of Sciences [NAS], 2011). The liabilities faced by the FAA result from the development of wetland habitats in stormwater ponds and ditches on airport properties that receive fuel-impacted runoff. These wetlands are sometimes home to threatened and endangered species. Thus, a concerted effort by multiple agencies is currently underway to estimate the liabilities associated with the degradation of wetlands.

Wetlands provide critical ecosystem functions and are typically sensitive to disturbances related to environmental contamination (e.g., Figure 1-1; Lewis et al., 1999), and hydric soils within wetlands are often the ultimate contaminant sink due to their high sorption capacity associated with high organic content relative to other soil types (hydric soils can be defined as soils that formed under conditions of saturation, flooding, or ponding long enough during the growing season to develop anaerobic conditions in the upper part [National Resource Conservation Service [NRCS] http://soils.usda.gov/use/hydric/intro.html; Federal Register July 13, 1994]). Remediation of contaminated wetlands has often involved either monitored natural recovery or no further action (von Stakelberg et al, 2008). However, where risks have necessitated remedial action, excavation of hydric soils and off-site transport of excavated materials for treatment and disposal have been selected. This type of remediation is both expensive and destructive to hydric soil structure and valuable habitat. The majority of contaminated wetland areas where excavation is the primary response action will require post-excavation mitigation to restore wetland function and ecosystem services. Wetland restoration efforts following excavation can be expensive and successful restoration is challenging at best (Kusler, 2006a, 2006b). Because of the risk reduction and restoration challenges posed by aggressive remedies, lower impact alternatives that take advantage of, or enhance, natural recovery processes (ENR) are actively being tested and demonstrated, as presented by Patmont et al. (2013), Ghosh et al. (2011), and briefly described in Section 2 of this report.

Alternative remedial approaches that allow targeted *in situ* remediation of wetlands would result in tremendous cost savings with the added benefit of minimizing impacts on ecosystem components. However, *in situ* wetland remediation technologies present logistical deployment challenges equal to the challenges presented by removal technologies, due to the need to preserve the hydric soil structure and the presence of sensitive ecological receptors. The soil structure must also be preserved so as not to alter the hydrology of the wetland. Validated *in situ* technologies for addressing and mitigating hydric soil contamination would be applicable to many wetland areas requiring active remedial responses, reserving excavation, dredging, and other more extreme response actions for only the most highly contaminated areas where actionable risks are readily apparent.

1.2 OBJECTIVES OF THE DEMONSTRATION

The overall objective of ESTCP Project ER-200825 was to demonstrate and validate *in situ* wetland remediation technologies designed to sequester contaminants in wetlands without adversely impacting the ecology of these systems. The Canal Creek hydric soil field demonstration included an evaluation of a sequestration agent identified through bench scale testing (activated carbon [AC]). The work included the application and evaluation of two distinct sequestration agent delivery methods (slurry and pelletized systems were tested) within two distinct types of wetland systems (high value and low value) to determine which combination(s) provide the most cost-effective and environmentally protective solution(s). Monitoring was conducted following the demonstration to validate project success. Specific objectives of the demonstration included:

- Evaluate the ability of AC to reduce the bioavailability of (and risks associated with exposure to) PCBs in wetland habitats at the Canal Creek site using a variety of AC delivery systems;
- Provide cost performance data relative to selected sequestration agents and delivery methods;
- Obtain regulatory agency and trustee acceptance of *in situ* technologies to remediate contaminated hydric soils [e.g., USEPA, National Oceanographic and Atmospheric Administration (NOAA), United States Fish and Wildlife Service (USFWS)]; and
- Transfer the technology to other DoD and professional organizations.

1.3 REGULATORY DRIVERS

Federal and state agencies routinely mandate that the DoD and other responsible parties conduct remedial actions to address contamination in wetlands. Relevant regulatory drivers include the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) and the Clean Water Act (CWA), as well a variety of state wetland protection statutes. The Canal Creek study area has been subject to considerable remedial investigation under the CERLCA program. As a result of the CERCLA regulatory drivers, a determination has been made that unacceptable risks to human health or the environment may be present in portions of the Canal Creek system.

Wetland alteration concerns are not trivial: long-term harm to mature ecological communities may result from overly aggressive remedial strategies. Whenever remedial response actions in sensitive ecological systems are contemplated, it is important to balance the potential risks associated with chemical stressor exposure and the potential risks associated with wetland habitat alteration. As described in USEPA's *2005 Contaminated Sediments Guidance for Remediation of Hazardous Waste Sites*, Executive Order 11990 promotes the avoidance by federal agencies, to the extent possible, of the adverse impacts associated with the destruction or loss of wetlands if a practical alternative exists. This concern has been explicitly recognized by USEPA since the mid to late 1990's. The Office of Solid Waste and Emergency Response (OSWER) Directive 9280.0-03, *Considering Wetlands at CERCLA Sites* (USEPA, 1994), contains further guidance on addressing this Executive Order. USEPA Ecological Risk Assessment Guidance (1999) states that "even though an ecological risk assessment may demonstrate that adverse ecological effects have

occurred or are expected to occur, it may not be in the best interest of the overall environment to actively remediate the site". A review of remedial decisions indicate that remedial goals at DoD sites historically have been based on conservative default screening values rather than actual risk-derived cleanup standards that incorporate bioavailability and remedy risk management considerations (von Stackelberg et al., 2008).

An EPA Science Advisory Board (USEPA, 1990) review of relative ecological risks indicates that environmental protection strategies should prioritize remedial options for the greatest overall risk reduction. USEPA (1990) recommends that the relative risks of remedial strategies be considered, particularly as they relate to natural ecosystem destruction. Habitat alteration may result in greater relative risk than environmental contamination. The terms "acceptable risk" and "remediable risk" are used here for the purposes of risk communication. Risks of an intermediate category are not always so compelling as to require remediation, but may, depending on the balancing of a number of site-specific factors, including costs, health risks, and the risks associated with remediation (e.g., habitat destruction; see Figure 1-2). Based on the lack of human health risk from hydric soil exposure at many wetland sites, and the uncertainties associated with ecological risk analyses at these sites, it is likely that many DoD wetland sites fall into an intermediate category (Suter, 1993).

Figure 1-2 Freshwater Tidal Wetland

The use of innovative technologies such as the current demonstration that result in *in situ* remediation without destroying or functionally altering wetland ecosystems has the potential to result in remediation cost savings with minimal loss of ecological function; these technologies could serve as viable alternatives for the management of wetland sites with intermediate risk levels. *In situ* remediation technologies applied to wetlands and as discussed in this report may be considered an ENR remedy, that ideally includes a long term monitoring component, or may be classified as Enhanced Monitored Natural Recovery (EMNR). Use of *in situ* technologies aligns with a wide variety of federal and state-led green and sustainable remedial approaches (Ghosh et al., 2011). For instance, the federal government is actively pursuing a sustainable approach to all its activities in accordance with Executive Orders 13423 (2007) and 13514 (2009), and recent guidance documents (Department of Navy [DON] 2012a, 2012b; DoD, 2009; USEPA, 2008a). Less invasive *in situ* technologies may be deemed more often viable when sustainability metrics are included in remedial decisions. The selection of monitored natural recovery (MNR) or ENR remedies may be driven by short term risk (Stern et al., 2004), depending on burial rates, predicted residual concentrations and other considerations. The application of amendment materials for ENR remedies may raise important habitat alteration considerations that also need to be considered during the technology selection process (Chadwick, 2008).

2.0 TECHNOLOGY

In situ wetland remediation as applied in this project is considered the application of an amendment to the biologically active zone (BAZ) of a wetland in an effort to chemically isolate identified contaminants of concern (COCs) from potential ecological and human receptors (Luthy et al., 1997; NRC, 2003; Ghosh et al., 2011). This section describes the in-situ sequestration technology, its development, and advantages and limitations.

2.1 TECHNOLOGY DESCRIPTION

In situ wetland remediation using sequestration agents is a remedial treatment process involving the selection of appropriate agents for sequestration of recalcitrant contaminants present, application of those agents to the wetland soils, and monitoring to ensure effective performance. *In situ* wetland remediation is intended for surface applications within the BAZ to limit contaminant uptake by the local benthos (Ghosh et al, 2011). The *in situ* remediation technology evaluated in this study used engineered sequestration agents containing AC to reduce the bioavailability and toxicity of PCBs in hydric soils. Sequestration agents were mechanically deployed over the surface of a wetland and allowed to naturally integrate into the surface layer of the hydric soil through natural mixing processes (i.e., bioturbation, tidal cycles, root mixing, etc.), though the relative importance of each mixing process has not been characterized at this site, nor has the degree of mixing. Given the lack of a benthic macro-infaunal community at the site evaluated in this study, the role of bioturbation is uncertain. Incorporation of sequestration agents into the biologically active zone increases the partitioning of PCBs to the bulk phase and limits PCB bioavailability to benthos (Figure 2-1). It is important to note that the goal of this approach is risk reduction, not mass removal; therefore, performance is gauged through the reduction in contaminant bioavailability following addition of the sequestration agents.

The appropriate use of this technology begins with identifying the proper sequestration agent to meet required remediation goals of a wetland site. Factors to consider in sequestration agent selection include chemical, physical, biological, geographic, social, and climatic conditions at the site. Agent selection will generally begin with a literature review or relevant engineering experience; however, treatment performance will likely need to be demonstrated in the laboratory and/or field prior the final deployment in order to demonstrate adequate risk reduction and to select an appropriate application method (Ghosh et al., 2011). At the point the agent and delivery methods are established and any required regulatory approvals obtained, the full scale application can be conducted. Performance metrics must be established and monitored to verify that risk reduction is accomplished in a manner and within a timeline consistent with the site-specific remediation goals. The generalized treatment process flow is summarized in Figure 2-2. Table 2-1, adapted from Patmont et al., (2013), presents a summary of completed and ongoing AC and biochar pilot projects that have been conducted in wetland settings.

Figure 2-1 Conceptual Model of *In Situ* Wetland Remediation
(a) Wetland Immediately Following the Application of Sequestration Treatment
(b) Wetland with Dispersed Treatment Limiting Bioavailability of COCs

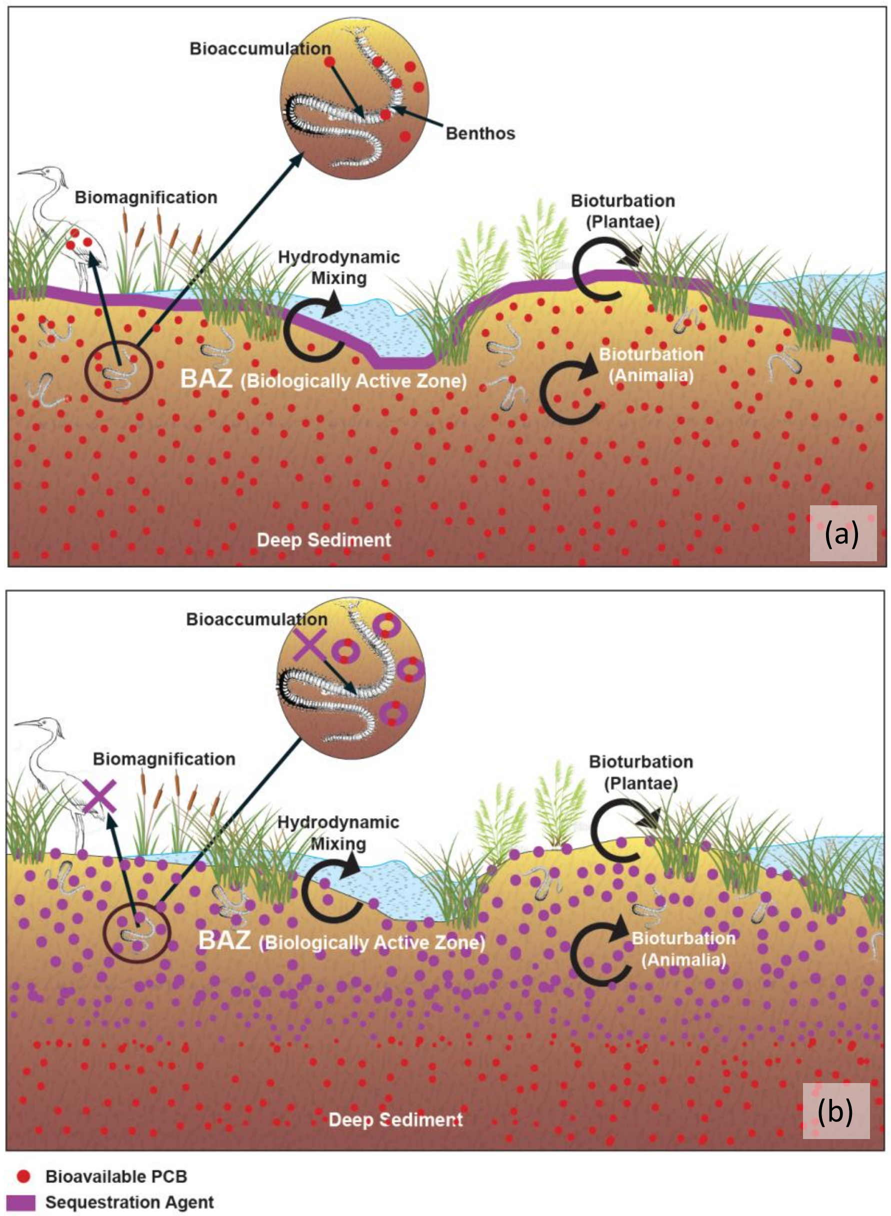

Figure 2-2 *In Situ* Wetland Remediation Process Flow Diagram

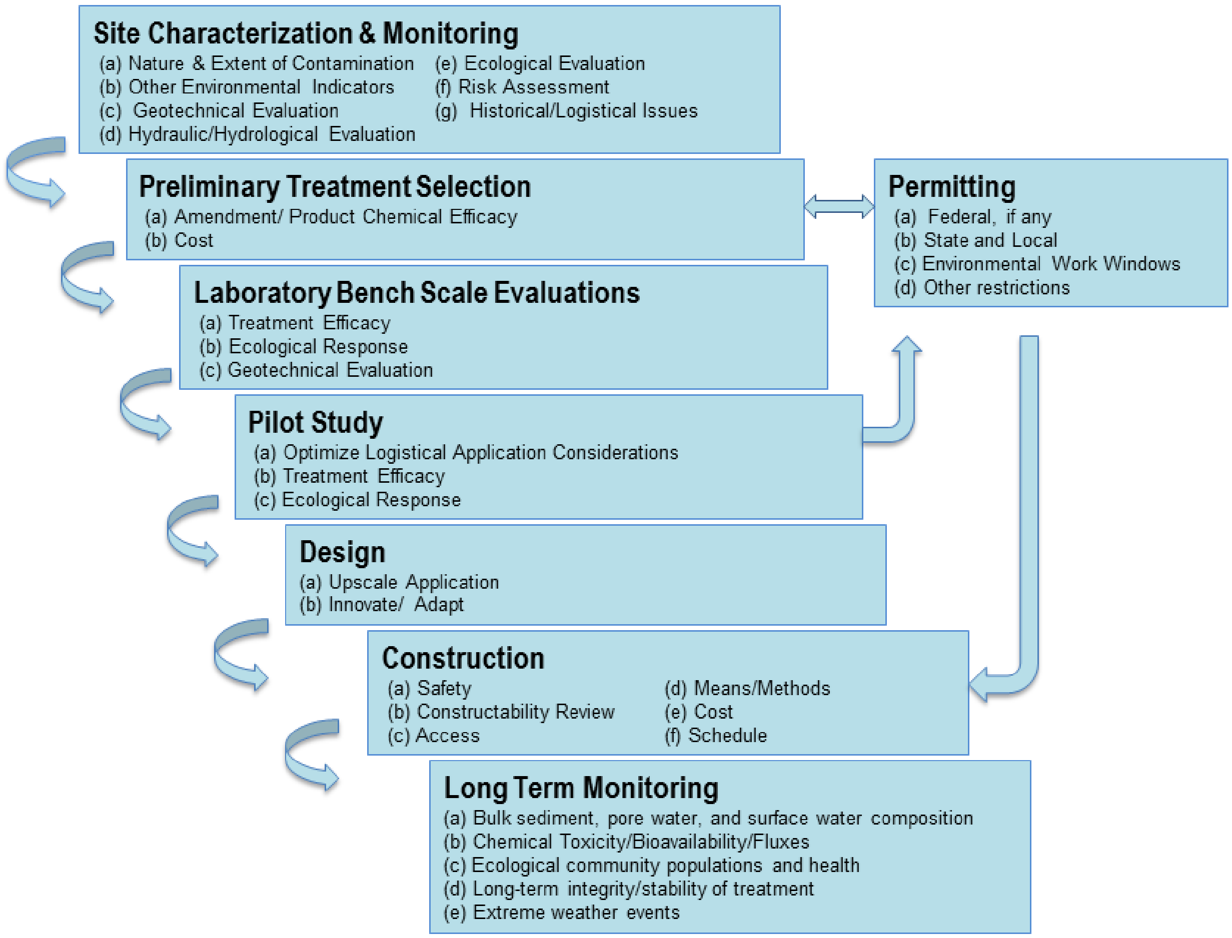

Table 2-1 Summary of Completed and Ongoing AC and Biochar Pilot Projects in Wetland Hydric Soil Settings

Completed AC and Biochar Field Pilots				
Site	**Contaminant**	**Year initiated**	**Treatment Applied in Intertidal Zone?**	**Key Findings**
Grasse River, Massena, NY	PCBs	2006	No	Bioaccumulation reduction with AC mixed into or placed on sediment
Bailey Creek, VA	PCBs	2009	Yes	Bioaccumulation reduction with AC placed in freshwater wetland
Canal Creek, MD	PCBs & mercury	2010	Yes	Additional evaluation required Reduction with AC placed in freshwater wetland
AC and Biochar Field Studies Underway				
Site	**Contaminant**	**Year initiated**	**Treatment Applied in Intertidal Zone?**	**Key Findings**
Berry's Creek, NJ	Mercury & PCBs	2012	Partial	Evaluate bioavailability control in vegetated wetland

Note: The information in this table was adapted from Patmont et al.., 2013 with permission.

2.1.1 Sequestration Agent Descriptions

Sequestration agents are selected based on the properties of the contaminants present, the relative affinity of the agents for these contaminants, the strength/permanence of the bond formed, and other considerations including the potential for adverse impacts attributable to the sequestration agent itself. In general, sequestration agents consist of a reactive amendment and a delivery material/matrix; however, agent designs may vary significantly. Three AC sequestration agents were evaluated in this study. Agents were selected from currently available technologies based upon a literature review and a laboratory treatability study. Descriptions of these products are included below.

- **Activated Carbon Slurry** – An activated carbon slurry was prepared on-site by slurrying AC with off-site water trucked in from a local pool supply company. The slurry was prepared within a hopper attached to a hydro-seeder used for agricultural field applications. The agitator within the hopper was used to mix the slurry; sufficient AC was added to produce a 35-40% slurry carbon concentration, by mass. The powdered AC (PAC) used in the slurry was distributed by Calgon Corporation

(WPH®) and is a virgin bituminous based material (90% passing through #325 mesh sieve).

- **AquaBlok®** – AquaGate+PAC, referred to as AquaBlok® in this report, is a proprietary composite sequestration agent. AquaBlok® is a manufactured aggregate core, coated with reactive material. The size of the aggregate (nominal American Association of State Highway and Transportation Officials System (AASHTO) #8 (1/4-3/8”)) and the overall size of the reactive material-coated granule can be adjusted to address project-specific needs. In a subaqueous application, the size is adjusted for the required settling characteristics. For a hydric soil-based application such as in this demonstration, the sizing is based on site-specific considerations including the reactivity of the coating, carbon dosing requirements, and *in situ* soil permeability requirements. The final formulation developed for the field project was the AquaBlok®+PAC 5% (No. 8), which consists of 5% bituminous coal based activated carbon, 10% bentonite clay, and 85% aggregate by weight.
- **SediMite**™ – SediMite™ is a proprietary composite sequestration agent. It is categorized as a dry broadcast pelletized amendment. SediMite™ was supplied for this demonstration by Dr. Upal Ghosh of the University of Maryland, Baltimore County. The material is an agglomerate consisting of a proprietary blend of powdered activated carbon; weighting agent and inert binder. In dry broadcast as well as subaqueous applications, the weighting agent is designed to provide ballast during application and prevent resuspension *in situ*. As the agent weathers, the binder is designed to structurally deteriorate and release PAC within the biologically active zone. The SediMite™ provided to this demonstration was 50% coconut- and coal- based activated carbon by weight.

2.2 TECHNOLOGY DEVELOPMENT

In situ wetland remediation through sequestration has potential application for reducing bioavailability of many contaminants (Bridges et al., 2008). Several amendments have been well characterized in both the laboratory and the field, including: apatite, organoclays, coal by-products, charcoal, zero-valent iron, sulfur-infused AC, and/or zeolite (USEPA, 1994; USEPA, 1997; Renholds, 1998; Reible, 2004; Barth and Reible, 2008; Knox et al., 2008; and Ghosh et al., 2010 and 2011). These amendments have been demonstrated to adsorb, de-chlorinate or otherwise remediate specific contaminants through various physio-chemical processes.

The science and engineering of PCB adsorption to AC is well understood and has been successfully applied to the remediation of soils, and most recently, to sub-aqueous sediments (Ghosh et al., 2011; Patmont et al., 2013). Environmental investigations have determined that AC is an appropriate amendment for the *in situ* treatment of similar compounds including hydrophobic organic contaminants (HOCs) and metals (Zimmerman, 2004; Walters, 1984; Hale et al., 2009). Effectiveness of AC in reducing contaminant bioavailability has been shown to improve with decreasing particle size, is dose dependent, and varies with the degree of mixing and contact time (Ghosh et al., 2011). Chemical stabilization and sequestration technologies have been most successfully applied at sites characterized by moderate or intermediate levels of risk to human health or the environment (Bridges et al., 2008). While these sorts of sites do not typically pose an imminent hazard or readily apparent harm which would require more active remedial risk

management, the potential for exposure and effects is not trivial, and some level of active risk management is clearly appropriate.

Similarly, non-reactive containment measures (e.g., thin layer caps [TLC] and isolation caps) have also been investigated as remedial treatment in contaminated wetlands. This remedial strategy differs from *in situ* active remediation in that, depending on thickness, it limits exposure of the BAZ to contaminated hydric soils (TLC) or it isolates the BAZ (isolation cap) using sand as an isolation barrier. Examples of non-reactive treatments applied to wetland hydric soils were demonstrated at Soda Lake, Wyoming (Thompson et al., 2004) and Pine Street Canal, Vermont (USEPA, 2011). *In situ* wetland remediation draws upon the established science and engineering experience of these practices, and attempts to create a permeable barrier within the existing biologically active zone of the wetland through the application of loose sequestration amendments. The innovative aspect of the technology is primarily associated with delivery of sequestration agents to wetland soils in such a way as to ensure effective distribution and permanent incorporation into the soil matrix, while minimizing disturbances to wetland ecology. Natural mixing forces (bioturbation, vegetative root/rhizome, and hydrodynamic forces) are the primary vector for delivery of the amendment into the BAZ, limiting the bioavailability of the COCs to the local benthos. Studies similar to this demonstration have demonstrated that these natural mixing processes do operate to varying degrees (e.g. Clarke et al., 2001). Figure 2-3 shows a vertical soil profile collected at Time 0, immediately after amendment deployment. Note, some AC appears to have already in-washed into soil void spaces between 2-inches to 3-inches below the top of soil. The degree to which natural mixing forces operate is expected to vary by site and potentially have seasonal variations. Similarly, the depth of the apparent BAZ will vary by site. The potential effects of these factors on treatment efficacy evaluation are discussed in Section 6 of the report.

Figure 2-3 Split Soil Core Shows Minimal Natural Mixing of AC into BAZ has Occurred at Time 0

The reduction in contaminant bioavailability within a wetland BAZ is the primary objective of low impact *in situ* active remediation approaches (Figure 2-1; see for example NRC, 2003; Semple, 2003; Interstate Technology and Regulatory Council [ITRC], 2011 for discussions on bioavailability). The referenced literature on bioavailability and *in situ* active remediation is largely based on COCs in sub-aqueous sediments (e.g. ITRC, 2011; Thompson et al., 2012; Patmont et al., 2013); however, the concepts and principles are generally transferrable to hydric soils, with the acknowledgement that specific wetland environmental conditions may differ from subaqueous sediment beds (e.g., moisture content, oxidation-reduction potential, temperature, dissolved oxygen) and as such, have the potential to effect bioaccumulation mechanisms relevant to specific COCs.

Although the *in situ* application of these sequestration agents has not been extensively evaluated in palustrine wetland systems, recognized terrestrial remedial principles apply: if materials such as apatite, activated carbon, zeolites, or other sequestration agents can be effectively delivered to the hydric soils, then toxicity, mobility, and bioavailability of inorganic and organic constituents can be reduced. Relatively low-tech delivery methods are well established for upland soils and are readily available technologies in other related fields (e.g., soil stabilization, dust control, wetlands and stream restoration, landscaping, agriculture, and irrigation). Sequestration agent delivery techniques established for other applications, such as landscape mulch distribution and agricultural fertilizer injection, were modified and adapted for use in this demonstration. Refinement of these technologies in the context of wetland systems (e.g., presence of standing water, fluctuating water tables, and type and density of vegetation) and amendment characteristics was an objective of this demonstration. See Appendix A for photographic log of site preparation, amendment deployment, Time 0 (soon after treatment application) and Time 2 (10 months post application) soil core photographs.

2.3 ADVANTAGES AND LIMITATIONS OF THE TECHNOLOGY

The following advantages and limitations should be considered by project managers making remedial decisions for wetland sites. As will be discussed further in this report, the efficacy of this treatment for reducing bioavailability of PCBs in wetland sediments was not conclusively demonstrated in this project. While the sequestration agents described in this report potentially allow targeted *in situ* remediation of hydrophobic organic contaminants in wetland hydric soils, the data from this demonstration and validation study were not conclusive. Although the AquaBlok® post-treatment benthic invertebrate tissue concentrations were statistically significantly lower than the pre-treatment concentrations, the other treatments did not show statistically significant reductions in the bioavailability of PCBs over the time frame evaluated within the project. Although statistically not significant, several other amendments resulted in arithmetically lower pore water and tissue concentrations post-application. Sufficient information was generated to show that activated carbon potentially could provide that sequestration without destroying or functionally altering wetland ecosystems, thus minimizing associated adverse impacts. Additional monitoring is necessary to determine whether this technology is applicable for further use at DoD contaminated wetland sites.

Amendments for the reduction of bioavailability of PCBs would be applicable to wetland areas with remediable risk requiring some type of non-time critical remedial response. More aggressive remedial alternatives such as excavation are typically very costly; the proposed low impact technology offers the potential for significant cost savings by avoiding costs of excavation and disposal of contaminated materials, and costs to restore the functional ecosystem of the site. The economic and ecological advantages offered by this approach, if demonstrated, could facilitate regulatory and stakeholder consensus more readily than more costly and invasive remedial alternatives.

Although a primary goal of this approach is to avoid harming mature wetland communities, it is possible that short-term impacts to the herbaceous community and forbs may occur. Measures that can be taken during implementation to avoid these short-term impacts are described in Section 5 and should be followed whenever possible; vegetation impacts should also be evaluated as part of the post-application monitoring program. Other potential challenges facing this technology include

the long term physical stability of the treatment under a wide variety of climatic and hydrodynamic conditions, differences in sorption behavior due to wetting/drying cycles, implementation related factors such as homogeneous amendment application in uneven terrain, application of sequestration agents in substrates that have limited vehicular access, and other logistical challenges.

Balancing trade-offs between removal and in-situ treatment, where contamination is left in place, is potentially a contentious subject. Cost consideration of remedial alternatives should include the potential ecological costs of both contaminant and non-contaminant (i.e., remediation) related effects.

Finally, technology evaluations should be developed with the understanding that the sequestration agent method of remediating wetland systems is still relatively immature. As a result, it is likely that full scale remedial efforts will require a larger investment in pilot scale evaluations and post treatment monitoring than conventional remediation practices.

3.0 PERFORMANCE OBJECTIVES

Quantitative and qualitative performance objectives were identified for the demonstration. The types and numbers of samples, analyses, and results are summarized in Table 3-1 and presented in detail in Section 5 where the results are summarized. Quantitative objects include remediation effectiveness, risk reduction and ecological community health, hydrological effects, and technology cost. Qualitative objectives include implementability/constructability, safety, stakeholder acceptance, and technology transfer to potential end-users. Table 3-2 summarizes the performance objectives, the evaluation metric, the criteria against which success was evaluated, and whether the objective was met. Each objective is discussed in the following sections.

3.1 QUANTITATIVE OBJECTIVES

3.1.1 Determine Remediation Effectiveness

The remediation technology will be considered effective when the pre-treatment bioavailability of the identified contaminant is reduced below specified risk thresholds, and this reduction is greater than that observed in the control plots.

Pre- and post-treatment PCB concentrations in the bulk hydric soil, pore water, and benthic receptor tissue were collected immediately prior to the treatment applications, and approximately 6 and 10 months following application. The sampling scheme is summarized on Table 3-1 and analytical and biological laboratory results are summarized in Section 5. Analytical data are presented in Appendix B and biological data are presented in Appendix C. Pore water concentrations were compared to established water quality standards, both pre- and post-treatment. Bulk soil/pore water partitioning coefficients were calculated and compared between treatments and the controls as well as pre- and post-treatment. Pre- and post-treatment PCB concentrations in benthic receptor tissues were also compared.

Standard statistical analysis (e.g., Analysis of Variance [ANOVA], t-test) were used to evaluate the significance of changes in dissolved pore water PCB concentrations and receptor tissue PCB concentrations, from 28-day bioaccumulation studies. Statistical significance was determined at the alpha = 0.05 level. The outcomes of the statistical outcomes are presented in Section 6 and the statistical results are included in Appendix D.

There is observational evidence that reduction in the bioavailability of PCBs occurred, on average, due to treatment by AC sequestration agents. The small sample size and heterogeneous PCB results within treatment plots and between pre- and post- application periods make a one-to-one comparison of pore water trends as a metric of treatment success challenging; therefore, results were averaged by treatment type and period for a first tier evaluation. Average pore water concentrations were observed to decrease within the treatment plots from the pre- to post-treatment monitoring events (13 of 17) and pore water concentrations on average were reduced from above to below the Maryland Acute Water Quality Standard (WQS) following treatment (6 of 8 averaged treatment evaluations). Pore water concentrations, except for AquaBlok®, were not statistically significantly different between pre- and post-treatment. AquaBlok® and Slurry Spray post-treatment pore water concentrations were statistically significantly lower than the post-treatment Control.

Table 3-1 Total Number and Types of Samples Collected

Component	Matrix	Number of Samples	Analyte	Location
Time 0 Baseline characterization December, 2010	Pore water	30	PCBs	1 grab sample per test plot, 10 composite samples from replicate plots[1,2] prior to treatment
	Hydric soil	30	PCBs	1 grab sample per test plot, 10 composite samples from replicate plots[1,2] prior to treatment
	Hydric soil	20	Grain size, organic content, black carbon, % moisture	1 composite per test plot[1]
	L. variegatus	30	PCBs	10 composite samples from replicate plots[1,2] prior to treatment
In situ samplers Deployed: April, 2010 Recovered: October, 2011	Pore water	20	PCBs	1 per test plot[1]
Time 1 Post-treatment monitoring June, 2011	Pore water	36	PCBs	1 grab sample per test plot, 12 composite samples from replicate plots[2]
	Hydric soil	36	PCBs	1 grab sample per test plot, 12 composite samples from replicate plots[2]
	Hydric soil	24	Organic content, black carbon, % moisture	1 composite per test plot
	L. variegatus	24	PCBs	12 composite samples from replicate plots[2]
Time 2 Post-treatment monitoring October, 2011	Pore water	36	PCBs	1 grab sample per test plot, 12 composite samples from replicate plots[2]
	Hydric soil	36	PCBs	1 grab sample per test plot, 12 composite samples from replicate treatments[2]
	Hydric soil	24	Organic content, black carbon, % moisture	1 composite per test plot
	L. variegatus	36	PCBs	12 composite samples from replicate treatments[2]

[1]SediMite™ treatment plots not sampled
[2]Composite samples were collected from two plots receiving the same treatment

Receptor tissue concentrations generally decreased within the treatment plots in the post-application monitoring. *Lumbriculus* receptor tissue concentrations were statistically significantly lower in AquaBlok® post-treatment compared to pre-treatment concentrations. *Lumbriculus* receptor tissue concentrations in Slurry Spray and Sand control were not statistically different when post-treatment data were compared to pre-treatment concentrations. However, AquaBlok® and Slurry Spray post-treatment *Lumbriculus* receptor tissue concentrations were statistically significantly lower than the post-treatment Control.

Because the pore water and tissue trends were not definitive, partitioning of PCBs was also evaluated as a general line-of-evidence. Pore water partitioning coefficients ($K_{bulk/pw}$) increased for all AC treatments as well as the untreated Control; however, only the relative increase in $K_{bulk/pw}$ for the AquaBlok® treatments was found to be statistically significantly greater than the Control. Statistically significant increases in $K_{bulk/Lv}$ relative to the Control were observed for the AquaBlok® and Slurry Spray plots. PCB pore water to bulk phase partitioning ($K_{bulk\backslash pw}$) and tissue to bulk phase partitioning ($K_{bulk\backslash Lv}$) was observed to increase within the AC treated plots relative to the Control.

Table 3-2 Performance Objectives

Performance Objective	Evaluation Metric	Success Criteria	Objective Met?
Quantitative Performance Objectives			
Determine remediation effectiveness in terms of PCB stability and bioavailability	Pre- and post-treatment PCB concentrations in pore water, *in situ* pore water, and tissue measured over time	PCB pore water and tissue concentrations significantly reduced in treated plots compared to control plots.	**Pore water** – Pore water concentrations, except for AquaBlok®, were not statistically significantly different between pre- and post-treatment. AquaBlok® and Slurry Spray post-treatment pore water concentrations were statistically significantly lower than the post-treatment Control. While not statistically significant, other amendments showed arithmetically encouraging trends (i.e., slight reductions were observed for the Slurry Spray and SediMite™ pore water concentrations over time and post-treatment pore water concentrations in the SediMite™ and Sand control were also lower than the post-treatment Control.). **Tissue** - *Lumbriculus* receptor tissue concentrations were only statistically significantly lower for AquaBlok® post-treatment compared to pre-treatment concentrations. AquaBlok® and Slurry Spray post-treatment *Lumbriculus* receptor tissue concentrations were statistically significantly lower than the post-treatment Control. While not statistically significant, other amendments showed arithmetically encouraging trends (i.e., some reductions were also observed for the Slurry Spray, SediMite™, and Sand control tissue concentrations over time and post-treatment tissue concentrations in the SediMite™ and Sand control were also lower than the post-treatment Control).

Table 3-2 Performance Objectives (con't)

Performance Objective	Evaluation Metric	Success Criteria	Objective Met?
Quantitative Performance Objectives			
Evaluate resident plant community survival and health after treatment	Pre- and post-treatment plant community composition /diversity surveys	No substantial change to resident plant community	Yes
Evaluate benthic invertebrate population survival and health post treatment	Pre- and post-treatment invertebrate community composition /diversity surveys	No substantial changes in resident benthic invertebrate community	No - a paucity of benthic invertebrates in wetland environment limited robust evaluation of success criteria
Evaluate hydrological conditions after treatment	Hydrological conditions such as water stage, turbidity, and pH of the wetland prior to and after treatment	Application of amendment does not substantially alter wetland hydrology	Yes
Evaluate whether adding the amendment impacts nutrient uptake into plants	Plant growth and tissue nutrient concentrations from plants grown in treated and untreated soil.	No substantial reductions in plant nutrient uptake or growth	Yes - generally no deleterious effects observed
Estimate costs	Detailed cost performance analysis of the implemented technologies	More effective in cost to alternative technologies	Yes

Table 3-2 Performance Objectives (con't)

Performance Objective	Evaluation Metric	Success Criteria	Objective Met?
Qualitative Performance Objectives			
Evaluate the implementability /constructability of material deployment methods	Visual observations of application homogeneity and measurements of sequestration agent thickness and areal coverage Observations on site-specific constraints that might affect scalability of technology	Homogeneity of application – homogeneous/consistent sequestration agent coverage over area (both vertical and horizontal) Scalability – scalable to full scale	Homogeneity of application - Yes Scalability - Dry broadcast application method likely limited for large treatment areas.
Evaluate safety related issues	Documentation of safety related incidents and observations during field implementation	No safety hazard associated with technology implementation	Yes
Assess agency and industry acceptance of the technology	Develop understanding of state and federal regulatory agency and industry acceptance of technology Work plan review by agencies and/or trustees	Technology considered acceptable by state or federal regulatory agency as a remedial alternative Technology considered acceptable by industry as a remedial alternative	Uncertain. While environmental permitting authorities approved this project, no regulatory oversight was conducted. A recently issued EPA OSWER directive for use of amendments at sediment Superfund sites (USEPA, 2013) suggests general regulatory acceptance.
Transfer technology to potential end-users	Conference presentations and/or journal articles	Presentation at conference or in journal; presentations to DoD end users	Yes

3.1.2 Evaluate Resident Plant Community Health

The effect of amendment application on the health of the resident plant community was measured to assess whether the technology improved or had no effect on plant community health. Multiple wetland cover types were identified across the site, as described in Section 5 and detailed in Appendix E.

Resident plant community abundance and diversity was observed pre- and post-application to assess plant community health. The presence and abundance of invasive exotics was observed, and the percent aerial cover for trees, saplings, shrubs, vines, and forbs pre- and post-amendment application was measured. In addition, any post-application observations of early senescence, yellowing or stunting of vegetation, was documented.

Standard statistical analysis was used to evaluate the significance of changes to plant abundance, diversity and cover and comparisons were made between treatment plots at different times and between treatment plots and control plots to account for seasonal differences. The results of the statistical evaluation are presented in Section 6 and the statistical evaluation can be found in Appendix E. The performance objective for each of these parameters was assessed at the alpha = 0.05 level, with the objective being no significant difference in these parameters among the treatments. The remediation technology was considered successful if the post treatment plant community metric condition was within 25% of the pre-treatment conditions and/or concurrent controls. A 25% change in conditions has been previously used by USEPA and other agencies as a quantifiable measurement of ecological significance (e.g., USEPA, 1994).

Changes in diversity, richness, and relative cover between pre- and post-treatment time periods were observed that were greater than the 25% of plant community metric condition. These changes were generally in a positive direction within and among treatment and control plots between monitoring periods. These trends are likely attributable to seasonal growing season effects such as air temperature and fluctuating surface water and water table levels rather than impact from the treatments.

3.1.3 Evaluate Benthic Invertebrate Population Health

The effect of the remedial technology on the resident benthic invertebrate community was measured to assess whether treatment had a significant effect on the health of the invertebrate community.

Observations of benthic invertebrate community health were made between the treatment and control plots to evaluate the effect of the amendment application. Invertebrates were obtained by sieving a sediment core collected from within a plot, sorting, identifying benthic invertebrates to the lowest practical taxonomy in the field, and counting.

It was anticipated that significant change to resident benthic invertebrate community abundance and diversity metrics would be calculated using standard statistical analysis; however due to the extremely low recoveries in both the 6 and 10 month sampling events (71 total organisms and 19 total organisms, respectively) in treated and control plots, a semi-quantitative analysis was instead applied to the pooled number of macroinvertebrates within similar treatment and wetland cover

types. The benthic macroinvertebrate report is presented in Appendix F. The remediation technology will be considered successful if benthic community total count in the treatment plots is within 25% of the control plots. A 25% change in conditions has been previously used by USEPA and other agencies as a quantifiable measurement of ecological significance (e.g., USEPA, 1994).

Macroinvertebrate evaluations were inconclusive due to low recoveries, likely due to habitat limitations (the marsh system at this site does not support a traditional benthic community), as described in Section 5. Semi-quantitative analysis determined a difference in total populations between the control and treatment plots in high value wetlands at the 6 month sampling event (lower), but not the 10 month sampling event, likely due to life stage. No difference was observed in the low value wetland at either post-treatment sampling event. The evaluation is presented in Section 6.

3.1.4 Hydrological Conditions Following Treatment

Assessment of the hydrological conditions of the wetland was initially planned to evaluate whether conditions were altered by amendment application. This metric was anticipated to have potential significance during the planning stages, depending on which demonstration site was selected (freshwater versus brackish). During field deployment at the Canal Creek study area, a freshwater environment, it was determined that the application of thin treatment veneers to the small test plots was not materially altering the permeability of the wetland soil, nor were visual turbidity impacts observed to water quality. Thus, this metric was not quantitatively assessed.

3.1.5 Nutrient Uptake

The effect of amendment application on nutrient uptake in plants was measured to assess whether the technology adversely impacted the ability for resident plants to grow and acquire nutrients from treated soils.

A laboratory test was conducted by exposing plant seedlings to treated and untreated soils and a laboratory control soil. Plant survival, growth, tissue concentrations, and uptake factors were evaluated to assess the impact of the treatments on the plants. Performance was assessed at the alpha = 0.05 level, with the objective being no significant reduction in plant health or nutrient uptake in treated soils relative to the untreated soil. The results of the study are presented in Section 5 and the detailed report is contained in Appendix G.

No statistically significant reductions in plant survival, weight, or shoot length were noted for the treated soils relative to the untreated soil after 77 days. Uptake factors for most nutrients in the treated soils were either not different from or were statistically greater than in the untreated soil. Statistics are presented in Section 6. Only nitrogen and sulfur showed a statistically significant reduction in uptake factors for a treatment (i.e., the Slurry Spray for nitrogen and SediMite™ for sulfur) relative to the untreated soil. It is unknown how this reduction in uptake may affect plant health in the long term, but adverse impacts on plant survival, growth, and shoot length were not observed in SediMite™ treated soils (relative to untreated soil) during the 77 day duration of the test.

3.1.6 Cost Effectiveness

The remedial technology cost basis was assessed as compared to established remedial technologies that achieve the same performance objectives.

A detailed cost performance analysis was conducted to determine if the amendment application is cost effective. Section 7 presents the cost assessment.

The cost evaluation metric used for analysis was whether costs were within +/- 25% of alternative remedial technologies (e.g., excavation and wetland mitigation) that achieve the same risk reduction result.

The results of the cost model suggest cost savings of 20% to 60% may be possible as compared to traditional remediation by removal, but additional monitoring is needed to demonstrate effectiveness.

3.2 QUALITATIVE OBJECTIVES

3.2.1 Evaluate Material Deployment Methods

The implementability and constructability of different amendment deployment methods were evaluated. The even application of the amendment material, manpower or equipment requirements, and scalability for dry broadcast and slurry deployment methods were assessed.

Amendment homogeneity was observed during and after deployment and amendment thickness and area coverage were measured after deployment. Site-specific constraints affecting scalability of the remedial technology were noted.

Laterally and vertically homogeneity of distribution throughout the test plot and scalability to the largest test plots were analyzed.

Deployed carbon slurry yielded a thin veneer in treatment plots; the deployed granular amendment materials (AquaBlok®, SediMite™, and the manufactured soil amendments) had greater thicknesses and more variability. Among the granular treatments, the lateral and vertical distribution was more uniform with SediMite™ (0.5 inch ±0) than either AquaBlok® (2.1 inch ±0.5) or the manufactured soil (1.9 inch ±0.5).

3.2.2 Evaluate Safety Related Issues

The safety of the remedial technology was evaluated based on the ability of the field team to apply the amendments without generating un-safe conditions for workers. Work was conducted under a site-specific Health and Safety Plan (HASP). Safety related issues were evaluated by documenting any safety related incidents and observations of any possible safety issues associated with field implementation. Clearance for unexploded ordnance (UXO) was required and conducted prior to implementation of any demonstration sampling, or monitoring activities.

A successful implementation of the remedial technology will have no safety incidents during implementation, and any observed potential safety issues for future implementation documented.

Approximately 600 hours were spent in the field injury free and more than 1,000 hours were spent in the laboratory injury free. Safety observation reports during the field activities noted the presence of deer ticks in the wetlands, potential cold weather exposure, and stop work conditions related to high water and inclement weather. No activities were modified or stopped due to technology-related hazards.

3.2.3 Assess Technology Acceptance

The acceptance of the technology by regulatory agencies and the environmental industry was evaluated during the permitting process. This plan was reviewed by the US Army Corps of Engineers (USACE), the Maryland Department of Environment (MDE), and USEPA prior to field implementation.

Although no regulatory oversight of this project occurred, from an environmental permitting perspective the use of surface-applied AC as a remedy for impacted wetlands on a small scale was accepted by MDE and the USACE. The USACE specifically determined that the permitted activity did not constitute discharge of a fill material to waters of the U.S. due to the nature of how the AC amendment gets incorporated into the soil. Issuance of permits by USACE and MDE, as well as implementation of full or partial remedy technology, illustrates the acceptance of the technology by the regulatory permitting authorities at the demonstration scale, however does not speak to overall stakeholder or regulatory acceptance. The technology has received industry support at technical conferences with published, peer-reviewed abstracts, and the recent publication of an EPA OSWER directive for use of amendments at sediment superfund sites (USEPA, 2013) suggests a trend towards regulatory acceptance.

3.2.4 Technology Transfer

The results of the technology demonstration were transferred (and continue to be transferred) to potential end-users via professional conference presentations and posters (e.g. Battelle International Conference on Contaminated Sediments, Society of Environmental Toxicology And Chemistry (SETAC), American Society for Testing and Materials (ASTM) Sediments Conference), internal AECOM and Navy webinar presentations, stakeholder meetings, permitting agency meetings, and multiple presentations to the Army Aberdeen Proving Grounds team. Technology transfer was also conducted as part of the permitting process, with team presentations at several MDE and USACE meetings.

4.0 SITE DESCRIPTION

The criteria, the selection process, and the rationale for the selection of APG as the demonstration site, as well as site background information, were presented in detail in the January 2009 *Site Selection Memorandum for ESTCP Project ER-200825 In Situ Wetland Restoration Demonstration*, approved by ESTCP on March 16, 2009, and are summarized below.

4.1 TEST SITE LOCATION AND HISTORY

The APG is an approximately 72,000-acre military installation located in portions of the southeastern Baltimore County and southern Hartford County, Maryland and is bounded by the Susquehanna and Gunpowder Rivers, the Chesapeake Bay, and the AMTRAK Railroad. APG comprises two principal areas, separated by the Bush River: the northern area known as the Aberdeen Area; and the southern area, formerly the Edgewood Arsenal, known as the Edgewood Area. The APG provides large areas of natural wetland habitats. Excluding wetlands within the open water areas, the wetlands at APG total about 13,600 acres or about 35 percent of the land surface area. Non-tidal wetlands total over 6,000 acres with approximately 1,770 acres of emergent wetlands, 4,350 acres of forested wetlands and 134 acres of scrub/shrub wetlands.

Canal Creek is located on the Edgewood peninsula, which is situated between the Gunpowder River to the west and the Bush River to the east. The Canal Creek Marsh and Landfill area is located within the Canal Creek Study Area (CCSA), which is a 1,600-acre study area in the northern region of the Edgewood Area. The CCSA has been an important chemical warfare research and development center for the United States since 1917. Past activities in the CCSA included laboratory research, field-testing, and pilot scale and full scale chemical materials manufacturing. Other activities included operation of machine and maintenance shops and garages, fabrication of metal parts, degreasing, and metal plating. Prior to the late 1960s/early 1970s, almost all municipal and industrial wastewater generated by CCSA facilities were discharged to Canal Creek and its associated marsh. Portions of the marsh associated with Canal Creek were used for landfilling of sanitary wastes and production waste disposal. Chemicals of potential concern (COPCs) included chemical warfare material degradation products (CWMDPs), PCBs, metals (e.g., mercury, arsenic, lead), explosives, solvents, and petroleum products and lubricants. The demonstration site is located along the West Branch of Canal Creek (Figure 4-1).

4.2 SITE GEOLOGY/HYDROGEOLOGY

Canal Creek is a non-tidal to tidal oligohaline to freshwater creek that discharges into the Gunpowder River (Figure 4-1); the demonstration site is freshwater. The CCSA boundaries extend from the mouth of the creek in the south to a small wetland area north of Magnolia Road in the north, and from the western bank of the marsh in the west to Wise Road in the east. The portion of the creek within the CCSA consists of approximately 2 miles of creek with approximately 110 acres of associated tidal and non-tidal marsh. The salinity of the creek ranges from freshwater to approximately 5 parts per thousand (ppt) depending on season and rainfall.

The portion of Canal Creek subject to this ESTCP demonstration project is freshwater. The headwaters of Canal Creek are drainages and small streams north of Magnolia Road fed by

overland runoff and seeps. The creek begins as two separate branches – the East Branch and the West Branch - which merge at the Canal Creek Main Stem confluence approximately 0.6 miles upstream of the creek mouth on the Gunpowder River. While the Canal Creek marsh provides a continuous wetland habitat for fish and wildlife, the morphology of the West Branch, East Branch, and Main Stem are different.

The demonstration site is located along the West Branch of Canal Creek, just above Hanlon Rd (Figure 4-1). The West Branch originates as a non-tidal stream, which becomes a meandering tidal creek downstream of Magnolia Road. The creek is bordered by 45 acres of tidal marsh emergent vegetation with small areas of scrub-shrub and forested wetlands. The marsh forms several infrequently flooded side arms. The West Branch has been the site of extensive historic discharge of wastes and also receives inputs from contaminated groundwater via seeps.

4.3 CONTAMINANT DISTRIBUTION

Based upon previously conducted site investigations (US Army, 2008), PCBs, DDx, mercury and other metals were identified as the primary COPCs at the CCSA. Historic data indicated that elevated concentrations of PCBs, and to some extent DDx, were present in surficial hydric soil samples collected in the channel and wetland areas above Hanlon Road. The presence of PCBs and DDx in surficial hydric soils at concentration levels similar to those observed historically was confirmed during a 2008 field sampling event conducted at historic sampling locations in the area above Hanlon Road. Results of this sampling event are discussed in detail in the *Site Selection Memorandum* (NAVFAC ESC, 2009a).

Subsequent to completion of the *Site Selection Memorandum*, a field program was conducted in July 2009 to better delineate the extent of PCB and DDx contamination in hydric soils on the eastern side of Canal Creek. This program included collection of 46 surficial hydric soil grab samples for DDx, PCBs (as Aroclors), and Total Organic Carbon (TOC) analysis. PCB Aroclor analysis was selected over PCB congener analysis for use during this phase of the investigation as a cost-effective methodology to evaluate total PCB distribution within the wetlands; however, in later phases of work, PCB congener analysis was incorporated into the performance metrics for the project.

The pre-demonstration soil sampling results indicate extensive occurrence of elevated PCBs along the eastern side of Canal Creek, as shown on Figure 4-2, and sporadic occurrence of DDx in the study area, as shown on Figure 4-3. The PCB concentrations ranged four orders of magnitude, demonstrating a high degree of heterogeneity in the magnitude and spatial distribution of PCBs across the site. Although such a large variability creates the potential to confound analysis and interpretation in demonstration project outcomes, PCBs were retained for further evaluation for this demonstration project and the portion of the creek system with extensive PCB contamination was selected as the study area. Analytical results of the 2009 sampling event were previously summarized in tables presented in the *Field Demonstration Plan* (NAVFAC ESC, 2009b).

As depicted in Figure 4-4, the PCB-impacted area contains four different vegetative cover types:

1. **Low Value Community** Portions of the study area are dominated by a relatively “low value” wetland community containing a virtual monoculture of *Phragmites australis*

(common reed). Common reed is a tall perennial grass which occurs in wetlands throughout much of the Northern Hemisphere. In North America, native forms of common reed are considerably less vigorous than European forms and the species is considered an invasive species in most of the eastern states along the Atlantic Coast (http://plants.usda.gov). This portion of the site is seasonally saturated, but is rarely saturated by tidal conditions.

2. **High Value Community**. Much of the Canal Creek study area is covered with a diverse riverine tidal "high value" freshwater marsh system dominated by a variety of forbes and graminoid species, including cattail (*Typha latifolia*), arrowhead (*Sagittaria latifolia*), rushes (*Juncus* spp.), sedges (*Carex* spp.), wool grass (*Scirpus cyperinus*), pickerelweed (*Pontedaria cordata*), and swamp rose mallow (*Hibiscus palustris*). This portion of the study area is subject to the ebb and flow of the tide, with an observed tidal fluctuation of approximately 1 foot. In Figure 4-4, the high value wetland includes deep emergent marsh, shallow emergent marsh, and cattail communities.

The demonstration project was designed to evaluate differences, if any, between these ecological community types relative to the potential for PCB bioavailability reductions following sequestration agent application.

4.3.1 Potential for Canal Creek PCBs to be Bioavailable

Many wetland environments contain natural levels of total organic carbon (TOC) that may themselves sequester hydrophobic organics. TOC levels observed in the July 2009 Canal Creek sampling event ranged from 1.1% to 4%, and averaged 2.2% (NAVFAC ESC, 2009b). Despite this fact, several lines of evidence suggest that PCBs in the Canal Creek system are bioavailable and are potentially present in pore water at concentrations which may pose a bioaccumulation risk:

- The data presented in the *Canal Creek Baseline Ecological Risk Assessment* (US Army, 2008) indicate that PCBs are present in fish tissue at elevated levels, suggesting that these constituents are bioavailable.
- The July 2009 hydric soil data were used to estimate pore water concentrations of PCBs (see *Field Demonstration Plan*). The estimated pore water concentrations were compared against USEPA Region 3 surface water screening values based on food chain modeling. All estimated pore water concentrations of Aroclor 1242, Aroclor 1254, Aroclor 1248, and Aroclor 1016 exceeded the surface water screening values.

These earlier results indicate that even low levels of PCBs in the pore water may result in food chain impacts to wildlife receptors feeding within the wetland, and that addition of sequestration agents that could limit the bioavailability of these constituents may be potentially beneficial to inhibit bioaccumulation.

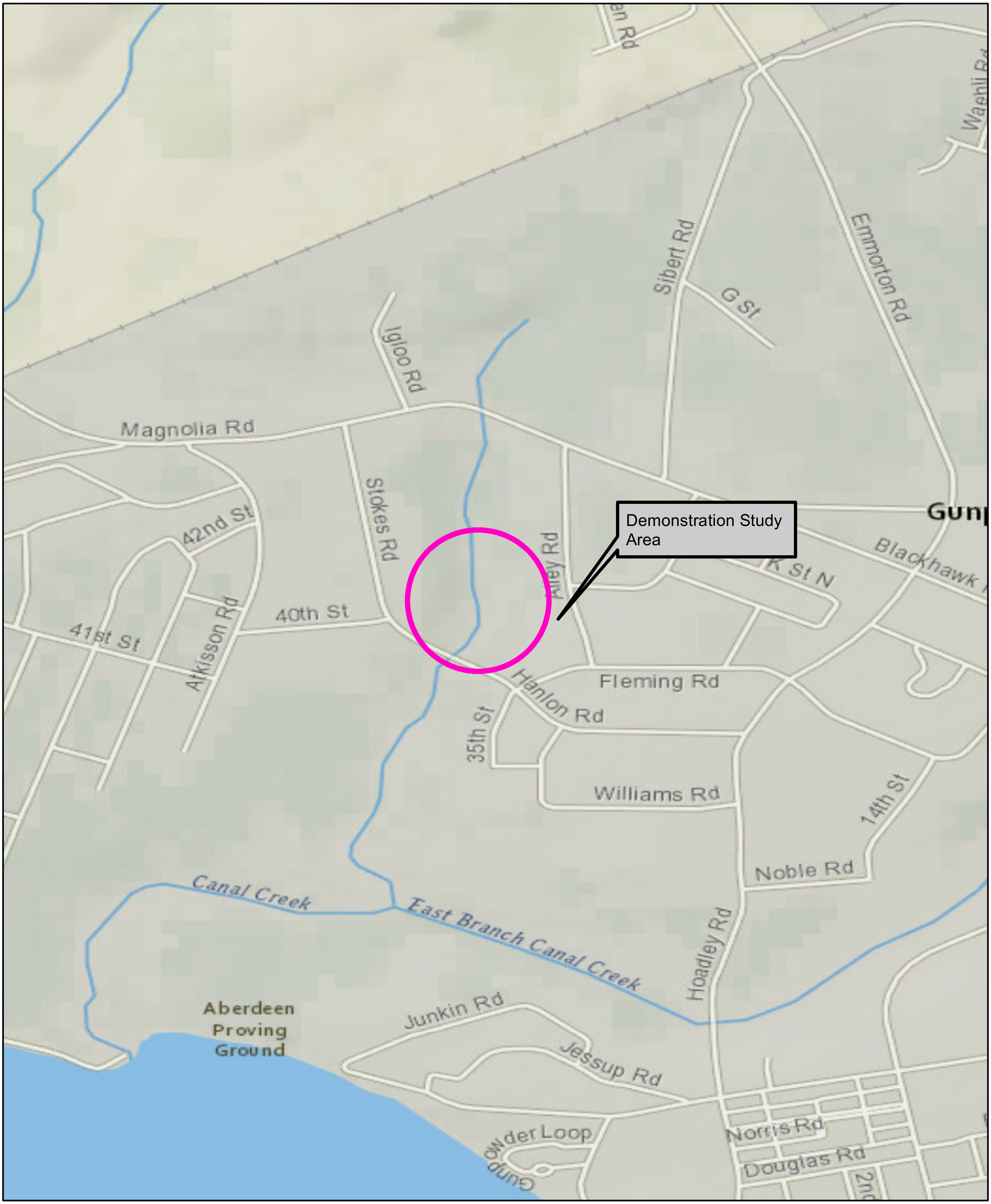

Figure 4-1
Canal Creek Study Area
Aberdeen Proving Ground
Edgewood, MD

Topo Source: 2011 National Geographic Society, i-cubed

0 750 1,500 3,000 Feet

AECOM

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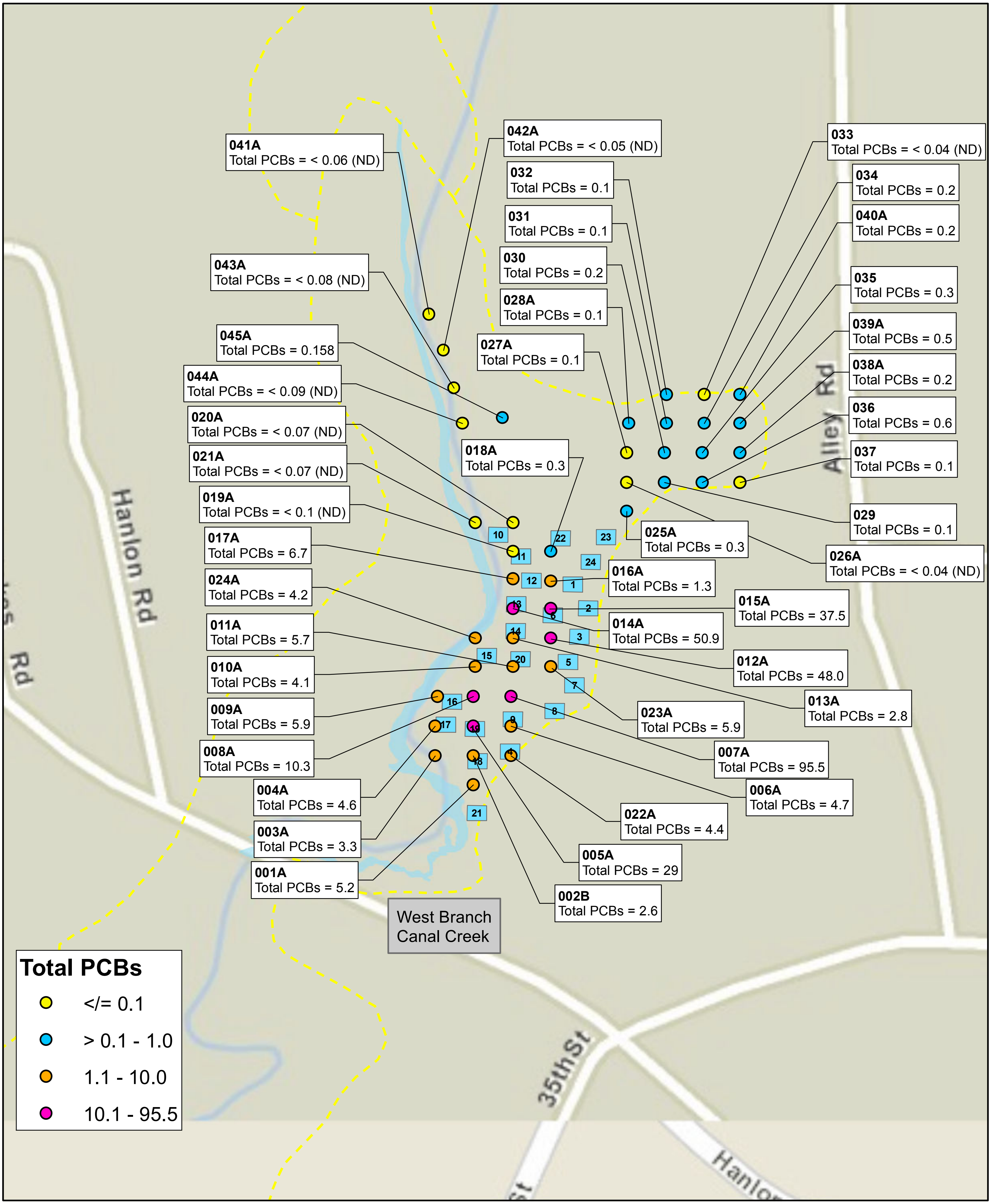

Figure 4-2
July 2009 PCB Sampling Results
Aberdeen Proving Ground
Edgewood, MD

NWI Wetland Boundary

Notes:
1) All data in mg/kg (ppm).
2) Duplicate samples are averaged.
3) PCB Aroclor method 8082

0 75 150 300 Feet

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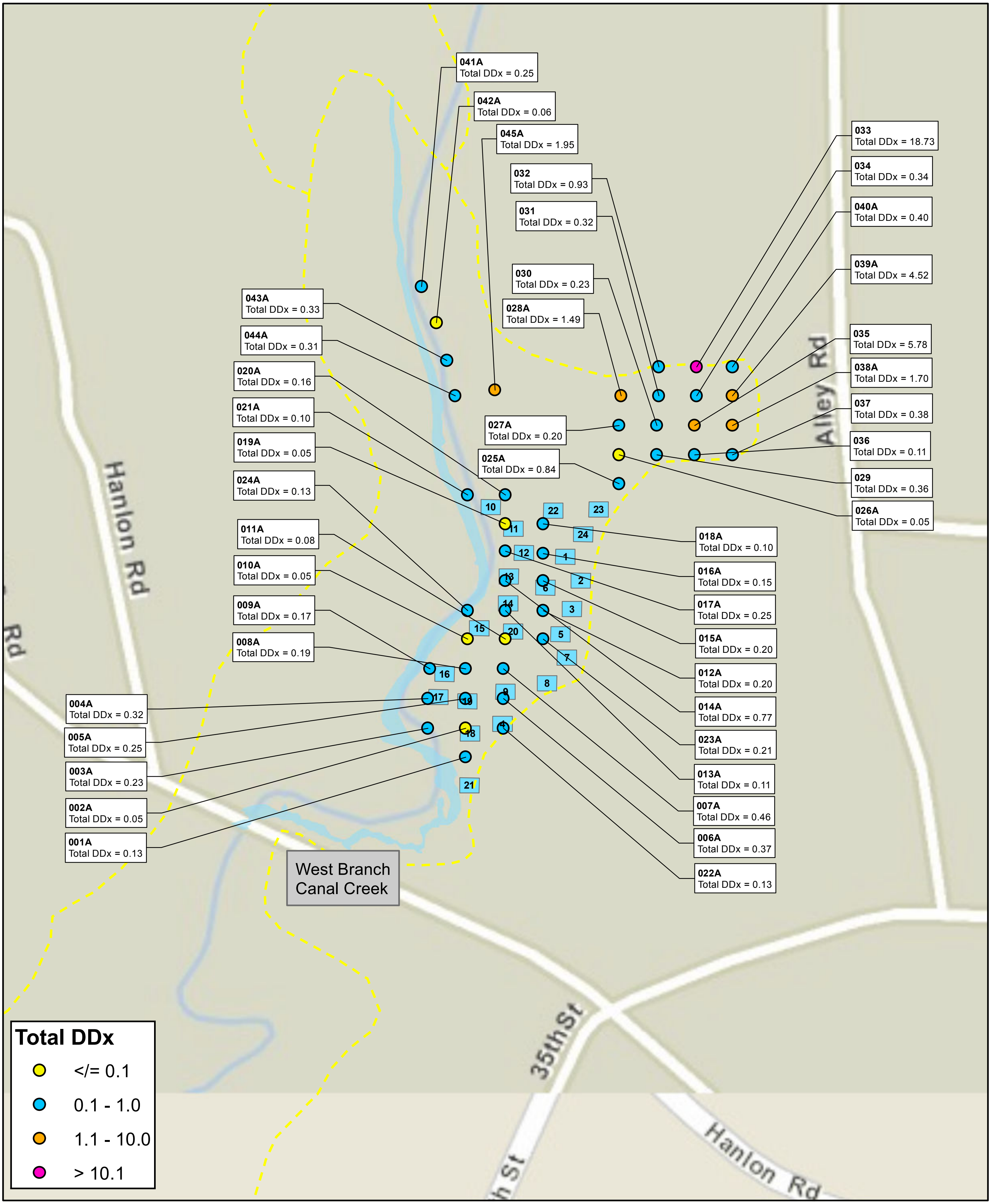

Figure 4-3
July 2009 DDx Sampling Results
Aberdeen Proving Ground
Edgewood, MD

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Notes:
1) All data in mg/kg (ppm).
2) Duplicate samples are averaged.
3) Pesticide method 8081

AECOM

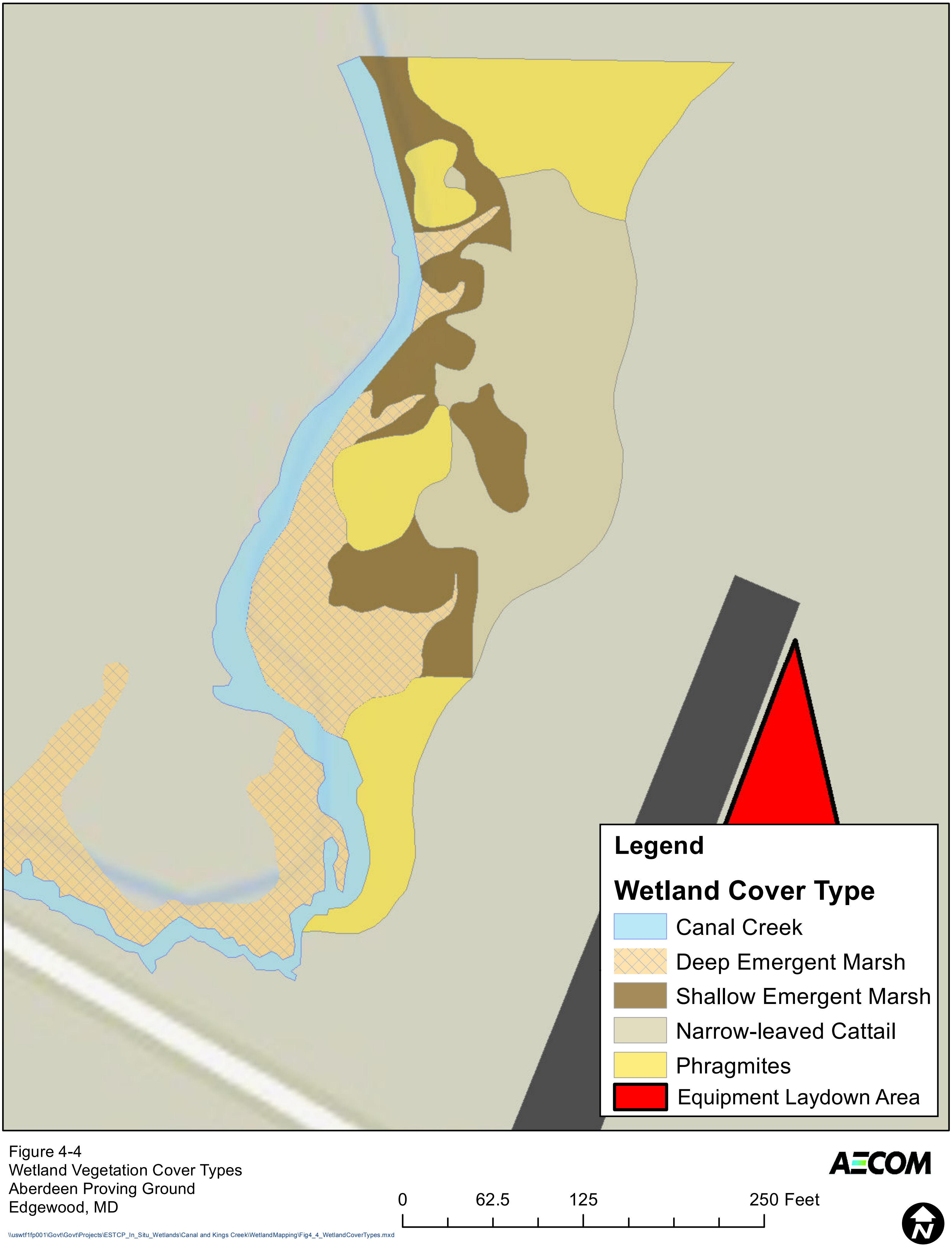


Figure 4-4
Wetland Vegetation Cover Types
Aberdeen Proving Ground
Edgewood, MD

\\uswtf1fp001\Govt\Govt\Projects\ESTCP_In_Situ_Wetlands\Canal and Kings Creek\WetlandMapping\Fig4_4_WetlandCoverTypes.mxd

5.0 TEST DESIGN

This section provides a detailed description of the demonstration design and the pre- and post-treatment testing conducted to address the performance objectives.

5.1 TREATABILITY STUDY

To support the Field Demonstration, focused laboratory treatability testing was performed with Canal Creek hydric soils, to screen several engineered sequestration agents and one dechlorination agent. The treatability testing results are described in the *Treatability Study Results* (NAVFAC ESC, 2009d). Amendments evaluated in the Treatability Study included PAC and organoclay (OC) for sequestration, and zero-valent iron (ZVI) for reductive dechlorination (biological and abiotic). Although the treatability studies initially focused on DDx and PCBs, due to the relative lack of DDx contamination in much of the CCSA, the PCB treatability study data were the relevant data for this demonstration project.

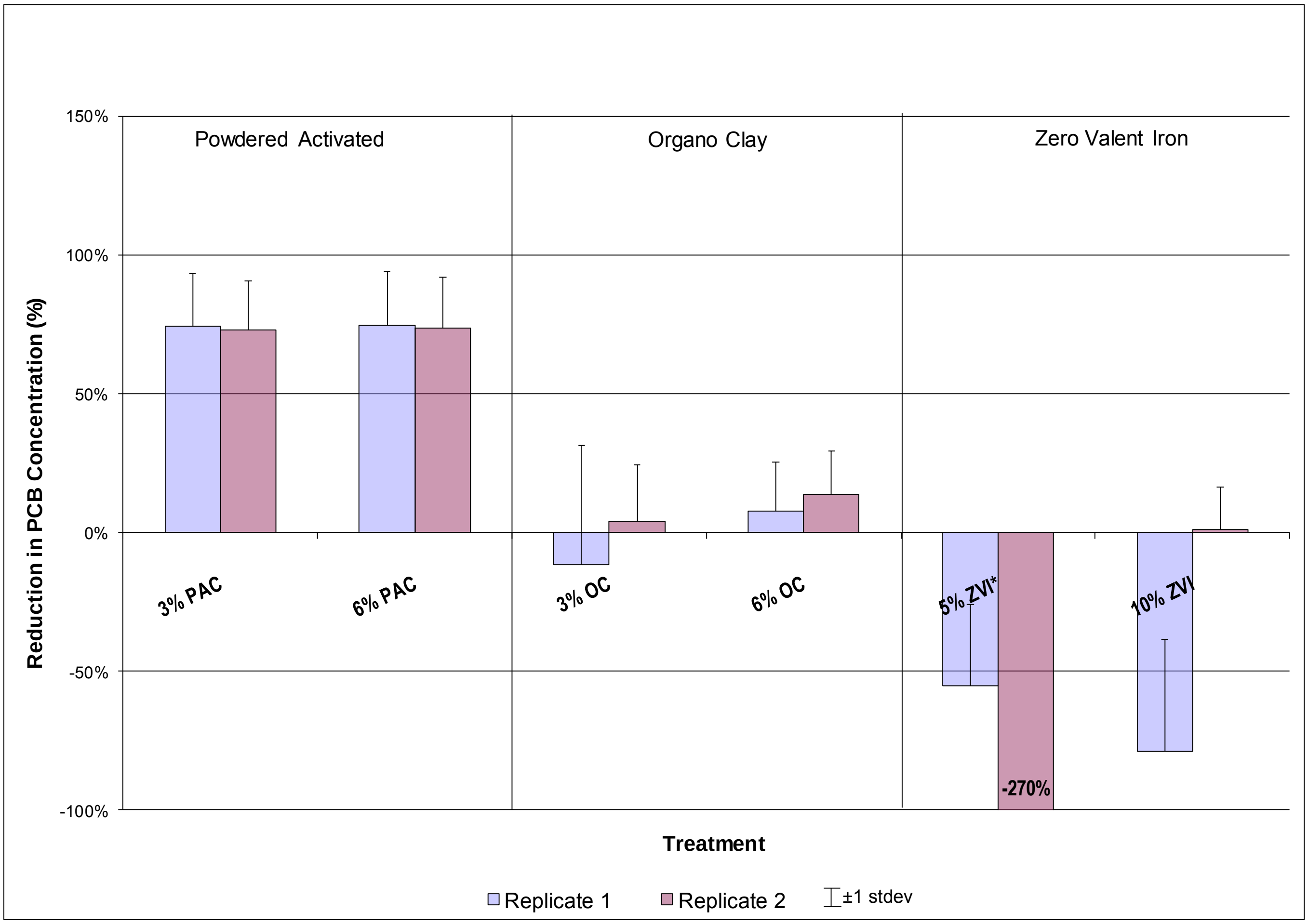
The primary objective of the Treatability Study was to determine the most effective amendment to be used in the Field Demonstration. Effectiveness was determined based upon an evaluation of reductions of PCB concentrations in hydric soil pore water following introduction of amendments and was confirmed by demonstrating reduced contaminant bioavailability in post-treatment laboratory bioaccumulation studies. The Treatability Study estimated the ultimate potential effectiveness of the *in situ* treatment under ideal laboratory conditions; site conditions and low-impact delivery methods are expected to achieve less thorough mixing and thus a less effective treatment.

The treatability tests were conducted by adding PAC, OC, or ZVI amendments to Canal Creek hydric soil. PAC and OC were added at 3% and 6%, respectively (dry weight), and ZVI was added at 5% and 10% (also dry weight). Figure 5-1 depicts reductions in pore water concentrations of five PCB congeners following amendment addition. These congeners were the sole quantifiable congeners (congener peaks that were consistent and in high enough concentrations to quantify) identified following a scan for all 209 congeners. The 29 congeners that were quantified by a modified USEPA method 8082A (gas chromatography/mass spectrometer [GC/MS] was used in place of Gas Chromatogaphy/Electron Capture Detection [GC/ECD]) are outlined, along with their homolog groups and reporting limits, in Appendix B. The 29 congeners accounted for >99% of the total PCBs within all the samples evaluated. The identified individual congeners' standards (AccuStandard) were then combined to formulate a quantification standard.

The Treatability Study results indicated that organoclays had marginal effectiveness for reducing PCB pore water concentrations, addition of ZVI resulted in increases in PCB availability, and the PAC amendment significantly reduced dissolved PCB pore water concentrations as sampled by solid phase microextraction (SPME) methods. Relative to the PAC amendment, there was no significant reduction in PCB bioavailability when the PAC concentration was increased from 3% to 6%.

The results of the Treatability Study indicated that amendment with 3% activated carbon by weight was the most appropriate amendment choice for the demonstration (NAVFAC, 2009d).

Figure 5-1 Average Percent Reduction in Dissolved PCB Pore Water Concentrations



Note: * Replicate 2 5% ZVI PCB Reduction = -270%

5.2 CONCEPTUAL EXPERIMENTAL DESIGN

Based on the results of Treatability Study, the AC amendments were deployed in the field using two methods: a sprayed slurry and dry broadcasting of pelletized AC.

- A sprayed slurry of PAC and water was used in areas that are not regularly flooded (e.g., in the lower value *Phragmites* wetland). The PAC slurry was delivered to the wetlands using a high solids sprayer. The design depth for the slurry was 0.5 centimeter (cm)
- Dry broadcasting of pelletized AC was used to distribute two different pelletized AC products in the intermittently flooded high value emergent marsh, as well as the lower value *Phragmites* dominated system. The dry broadcasting method was chosen for deployment of the pellets based on the nature of the wetland environment, the limited availability of support facilities (electrical power, water, etc.), access to the wetland,

and availability of the application equipment. The two products distributed via dry broadcast were AquaBlok® (Project ER-200825*)* and SediMite™ (Project ER-200835).

- AquaBlok® is composed of an aggregate core coated with reactive material. The size of the aggregate and, therefore, the overall size of the reactive material-coated granule can be adjusted to address project-specific needs. In a subaqueous application, the size is adjusted for the required settling characteristics. For a hydric soil-based application such as in this demonstration, the sizing is based on site-specific considerations including the reactivity of the coating, estimated treatment requirements, and permeability requirements. The formulation selected for the field project was the AquaBlok®+PAC 5% (No. 8), which consists of 5% activated carbon by weight, 10% bentonite clay, and 85% aggregate by weight. To achieve the required activated carbon application rate of 1.9 $kg/m^{2,}$ the pelletized carbon was applied to a depth of 0.055 m (5.5 cm) over the test plot (see Appendix H for mass calculation). 26 tons of AquaBlok® was required for the demonstration project and was delivered to the test site in tarped, 1 ton super sacks on standard plywood pallets.
- A second ESTCP-funded project team (ER-200835: Evaluating the Efficacy of a Low-Impact Delivery System for *In Situ* Treatment of Sediments Contaminated with Methylmercury and Other Hydrophobic Chemicals) delivered a second type of pelletized activated carbon, SediMite™, as described in the *Field Documentation Work Plan* ESTCP Project No. ER-200835, July 2009. The designed mass loading was 4.5 kg SediMite™/m^2 with an application rate of 10 kg/minute. The designed application thickness was 0.3 cm.

These two delivery systems depend upon naturally occurring mechanisms (e.g., bioturbation and herbaceous root growth) to vertically distribute the sequestration agent.

Two types of control plots were included in the demonstration experimental design.

1. Control plots receiving no material application and representing an un-remediated system; and,

2. Sand/soil control plots receiving an application of a sand cover system consisting of a manufactured soil that was engineered by mixing a loam soil and organic matter. The cover system was designed to mimic native soil permeability and TOC content. The manufactured soil cover system (referred to as Sand control) represents a treatment method commonly employed to manage residuals in remediated systems.

Thus, the bioavailability of PCBs in the amendment treated plots was evaluated against the bioavailability of PCBs in untreated and Sand control scenarios.

The demonstration comprises the following operational phases: Time Zero (Time 0) baseline characterization, demonstration study design and layout, field testing, and post-demonstration monitoring events at Time One (Time 1), six months post-construction, and Time Two (Time 2), 10 months post-construction.

5.3 PERMITTING

The CCSA is a CERCLA site, however, since this demonstration project was conducted outside the auspices of CERCLA, the regulatory authorities determined that state and federal permits were necessary to conduct the demonstration activities. USACE assumed the role of lead agency in cooperation with MDOE. The following permits were issued or exempted:

- Maryland State Programmatic General Permit, Category 3-- USACE Baltimore District
- Water Quality Certification- MDE
- Wetlands License- Maryland Board of Public Works Wetland Administration
- Soil Erosion and Sediment Control Plan - Harford County Soil Conservation District (exempted)

The USACE Baltimore District stated in the General Permit, "*It is anticipated the material applied to the test plots will break down and be incorporated into the existing sediments. Therefore, the work is not expected to entail a permanent placement of fill material.*"

The permit application process was initiated during remediation design and baseline characterization activities, which are described in the next two sections.

5.4 BASELINE CHARACTERIZATION

Prior to the application of the amendments, both the Canal Creek wetland demonstration site and the amendment were characterized. The July 2009 pre-demonstration investigation characterized the distribution of PCBs, DDx, and TOC in hydric soils throughout the wetland. The dominant vegetation and wetland hydrology were also characterized; two predominant wetland types were identified, as described in Section 4.0 and summarized in Appendix E. In addition to the pre-demonstration investigation, pre-treatment monitoring was conducted to establish baseline conditions within the wetlands, which included chemical analyses, laboratory bioaccumulation testing, and ecological evaluations. Sampling and analysis methods used for baseline characterization activities are the same as those used for the post-amendment application evaluations that are described in detail in Section 5.7.

Time 0 monitoring was conducted during two events, November 2009 and December 2010 while permit applications were in process. Monitoring and plot set-up consisted of the following tasks, which are described in Sections 5.4 and 5.6 and shown in Appendix B:

a. UXO clearance was conducted prior to baseline characterization, field deployment, and each sampling event using magnetometers and visual-manual methods.

b. Decontamination and lay-down areas were established.

c. Twenty-four test plots measuring 8 meters (m) by 8 meters (64 square meters) were staked out (Figure 5-2). Plots were identified by numbers 1 through 24 and given a prefix of “APG” (for Aberdeen Proving Grounds). Temporary sediment control products (e.g., 15 cm diameter straw wattles) were placed around the perimeter of each plot, temporary plywood walkways were established between plots and at access points for amendment application activities. Plot ecology was characterized.

Figure 5-2 Cleared Test Plots, Staked Sediment Control Products, and Temporary Walkways

i. Plots were delineated by locating one corner of the plot using pre-defined global positioning systems (GPS) co-ordinates. An eight foot wooden stake was placed at the located corner, and then the remaining corners were delineated using a compass and tape measure to obtain eight meter square plots. Sediment control products made of certified weed-free straw fibers that are encapsulated in UV stabilized netting were transported to each plot so as to minimize disturbance to the wetland system; these were placed around the perimeter of each plot to isolate the treatment, and staked in place by wooden survey stakes. Temporary walkways constructed of plywood were placed between plots and at access points to reduce foot pressure on the hydric soils, as shown on Figure 5-2.

ii. Within plots, plant species were identified and abundance, diversity, and total percent cover determined for the layers present (i.e., herbs, shrubs/saplings, vines and/or trees).

iii. Documentation of invasive plant species (in terms of square footage, per occurrence, by species). Once baseline vegetation surveys were completed, senesced vegetation was trimmed to allow treatment products to be applied to the soil (see Figure 5-3).

iv. The benthic community was sampled for abundance, taxa richness, Biotic Index, functional feeding groups, and other metrics.

Figure 5-3 Clearing of Senesced Vegetation for Test Plot

d. December 2010 hydric soil grab samples (0-6 inches) were obtained and characterized both chemically and physically.

   i. Total PCB pore water concentrations.

   ii. Total PCB bulk hydric soil concentrations.

   iii. Physical soil characteristics including grain size, soil pH, OC, black carbon, and percent moisture.

e. Bioaccumulation testing with oligochaete worm (*Lumbriculus variegatus*) to determine baseline conditions.

Table 5-1 presents definitions of ecological metrics and Table 5-2 presents a summary of the baseline monitoring observations:

- Plant species observations are included in Appendix E.
  - One-third of the test plots were predominately narrow leaved cattail
  - One quarter of the test plots were predominately common reed
  - Approximately one-third of the test plots were predominately emergent marsh
  - The remaining plots were a mixture of vegetation types.

- Tables summarizing the analytical results of bulk hydric soil, pore water, and *L. variegatus* PCB concentrations are provided in Appendix B.
  - Twenty-nine PCB congeners were identified within the hydric soil, pore water and *L.variegatus* in a qualitative (presence/absence) analysis. Different homologs were detected in the two media: pore water detections were for tri- and tetra- congeners while biota contained higher chlorinated congeners (up to hexa).
  - Pore water concentrations prior to the application of reactive treatments ranged over 5 orders of magnitude, ranging from 10^{-2} to 10^{-7} ug/l.
  - Macroinvertebrate tissue concentrations prior to the application of reactive treatments ranged over 4 orders of magnitude, ranging from 10^{+1} to 10^{-2} mg/kg.
  - Soil black carbon content ranged from 2.12% to 4.78% and typically had less than 1% black carbon content.
  - Grain size was predominantly silt and clay with most samples having less than 30% sand. Gravel content varied from 0 to less than 0.5%.

Appendix C contains the biological laboratory reports. No baseline observations were obtained due to a paucity of benthic organisms.

Table 5-1 Ecological Evaluation Metrics and Definitions

Plant Species Richness	The total number of species or taxa found in a 64 m^2 test plot.
Percent Cover	The percentage of vegetation, by taxa, that covers a 64 m^2 test plot.
Benthic Macroinvertebrate	The number of benthic macroinvertebrate organisms found in replicate soil samples collected from a 64 m^2 test plot. The number of organisms may be identified by taxa to genus or species.

Table 5-2 Baseline (Time 0) Monitoring Observations

Metric	Minimum Observation	Test Plot No.	Maximum Observation	Test Plot No.
Plant species richness	1	APG-21, APG-22, and APG-23	11	APG-3
Percent cover by area			>76% common reed	APG-21,APG-22, APG-23, APG-24
			>76% narrow leaved cattail	APG-03,APG-05, AGP-07, APG-08
Benthic Macroinvertabrate[1]	NR	NA	NR	NA
Bulk Hydric Soil PCB (mg/kg)	0.0169	APG-23	105	APG-06
Pore Water PCB(mg/L)	5.69×10^{-07}	APG-23	3.73×10^{-02}	APG-07, APG-03, APG-06
L. variegatus (mg/kg dw)	0.0243	APG-22/23	$5.32E^{+02}$	APG-06/24b
Natural carbon (%)	4.86	APG-07	31.12	APG-11
Black carbon (%)	0.2	APG-06	2.56	APG-12

[1] Very few macroinvertebrates were encountered during this survey and no samples were preserved.

NR = not recorded

NA = not applicable

ng/L = nanograms per liter

mg/L = milligrams per liter

5.5 DESIGN AND LAYOUT OF TECHNOLOGY COMPONENTS

The design and layout of the demonstration required determining the mass of amendment required to attain the optimal dosage as determined during the Treatability Study. The calculated mass of amendment was applied to select test plots following the layout described in this section.

5.5.1 Mass Calculations

The Treatability Study determined that the most effective treatment agent for PCBs was an amendment of 3% AC by mass of the hydric soils to be treated. Average wetland soils density and porosity were estimated and used to calculate the required AC application rate. Appendix H contains the soil mass calculations. Based on these calculations, 1.9 kilogram of AC per square meter (kg/m^2, equivalent to 0.4 pounds per square foot [lb/ft^2]) of wetland soil was needed to amend the top 15 cm (6 inches) of the wetland soils with 3% AC by weight. Table 5-3 summarizes the AC treatment design for the test plots:

- The AquaBlok® pelletized carbon has a density of approximately 1,400 kilograms per cubic meter (kg/m^3), equivalent to 89 pounds per cubic foot (lb/ft^3), of which 5% by weight is AC. This is equivalent to pure activated carbon with a density of 70 kg/m^3. The pelletized carbon was applied to a minimum thickness of 0.055 m (5.5 cm) over the test plots to reach the desired mass application rate of 1.9 kg/m^2 to dose a 15 cm layer of soil.
- SediMite™ pelletized carbon is 50% by weight AC. SediMite™ was applied to a minimum thickness of 0.003 m (0.3 cm) to dose a 10 cm layer of hydric soil with an application rate of 4.5 kg/m^2 (including a 25% safety factor).
- The design mass loading for PAC was 300 pounds AC to 875 pounds slurry per plot; this value was based on bench scale tests that indicated that the PAC slurry could be prepared to contain 30 to 50% AC by weight. This corresponds to a ratio of 0.3 to 0.5 kg PAC / liter of water or about 2.1 kg PAC/m^2.

Table 5-3 AC Treatment Design Mass Loading and Thickness

Treatment Type	Percent AC (by weight)	Design Mass Loading	Design Application Thickness
AquaBlok®	5%	1.9 kg/m^2	0.055 m (5.5 cm)
SediMite™	50%	4.5 kg/m^2	0.003 m (0.3 cm)
PAC Slurry Spray	30-50% (300 pounds AC to 875 pounds slurry)	2.1 kg PAC/m^2 0.3-0.5 kg PAC / liter of water	submillimeter
Sand control	0%	1.9 kg/m^2	0.05 m (5.0 cm)

SediMite™ design includes a 25% safety factor

Additional details regarding equipment and field methods for material placement are provided in Section 5.6.2.

5.5.2 Test Plots

As depicted in Figure 5-4 and summarized on Table 5-4, a series of 8 m by 8 m plots were established in the PCB-contaminated region that includes high value, low value and mixed high/low value wetland cover types. A subset of 20 plots was randomly selected for the Field

Demonstration. The 20 plots were field-demarcated using survey stakes and tape, with a minimum buffer of 8 m between plots. Sediment control products 15 cm in diameter were staked to separate individual plots to ensure that the amendments were isolated to their respective plots. The test plots were situated randomly within the wetland cover types identified in Table 5-4 and the dominant vegetation type for each test plot presented in Table 5-5.

- **Five replicate plots**: high value wetland, pelletized PAC delivery system (AquaBlok®);
- **Three replicate plots:** low value wetland, pelletized PAC system(AquaBlok®);
- **One replicate plot:** mixed high and low value wetland, pelletized PAC system(AquaBlok®);
- **Two replicate plots**: low value wetland, slurry PAC delivery system;
- **Two replicate plots**: high value wetland, slurry PAC delivery system;
- **Four replicate plots:** high value wetland sand control application control;
- **Four replicate plots:** high value wetland control.

Table 5-4 Number of Replicate Plots by Treatment for Wetland Value Types

Wetland Value Type	Treatment Type					Number of Replicate Plots
	Pelletized PAC (AquaBlok®)	Slurry PAC	Sand Control	Control	Pelletized PAC (SediMite™)	
High	X					5
Low	X					2
Mixed	X					1
High		X				2
Low		X				2
High			X			4
High				X		4
Total for Project ER-200825						***20***
High					X	3
Mixed					X	1
Total for Project ER-200835						***4***

The slurry PAC delivery system was not applied in inundated areas since the tidal influence within the freshwater marsh had the potential to dilute and wash away the slurry. In addition to the 20 plots described above, four plots were assigned to a second ESTCP-funded project team (ER-200835: Evaluating the Efficacy of a Low-Impact Delivery System for *In Situ* Treatment of Sediments Contaminated with Methylmercury and Other Hydrophobic Chemicals). These plots in the high value wetland were treated with SediMite™, a treatment material that contains AC and inert materials (e.g., clays), as described in the *Field Documentation Work Plan* ESTCP Project No. ER-200835, July 2009. The SediMite™ pelletized carbon is about 50% by weight AC. Due

to the much higher AC content, the pelletized carbon was applied to a thickness of just over 0.003 m (0.3 cm) over the test plots.

Table 5-5 Test Plot IDs by Wetland Area and Amendment Evaluated

Amendment	Plot ID, "APG-"	Dominant Vegetation Type	Wetland Type
Control	4	Shallow emergent marsh	High Value
	7	Narrow-leaved cattail	High Value
	12	Shallow emergent marsh	High Value
	15	Shallow to Deep emergent marsh	High Value
Sand Control[1]	1	Narrow-leaved cattail	High Value
	3	Narrow-leaved cattail	High Value
	10	Shallow emergent marsh	High Value
	14	Narrow-leaved cattail and Shallow emergent marsh	High Value
AquaBlok®	5	Narrow-leaved cattail	High Value
	6	Narrow-leaved cattail	High Value
	9	Shallow emergent marsh	High Value
	11	Shallow emergent marsh and Common reed	Mixed High and Low Value
	13	Shallow emergent marsh	High Value
	20	Shallow emergent marsh and Narrow-leaved cattail	High Value
	21	Common reed	Low Value
	24	Common reed	Low Value
SediMite™	16	Deep emergent marsh and Common reed	Mixed High and Low Value
	17	Shallow to Deep emergent marsh	High Value
	18	Deep emergent marsh	High Value
	19	Shallow emergent marsh	High Value
Slurry Spray	2	Narrow-leaved cattail	High Value
	8	Narrow-leaved cattail	High Value
	22	Common reed	Low Value
	23	Common reed	Low Value

[1] Sand control = manufactured soil cover system

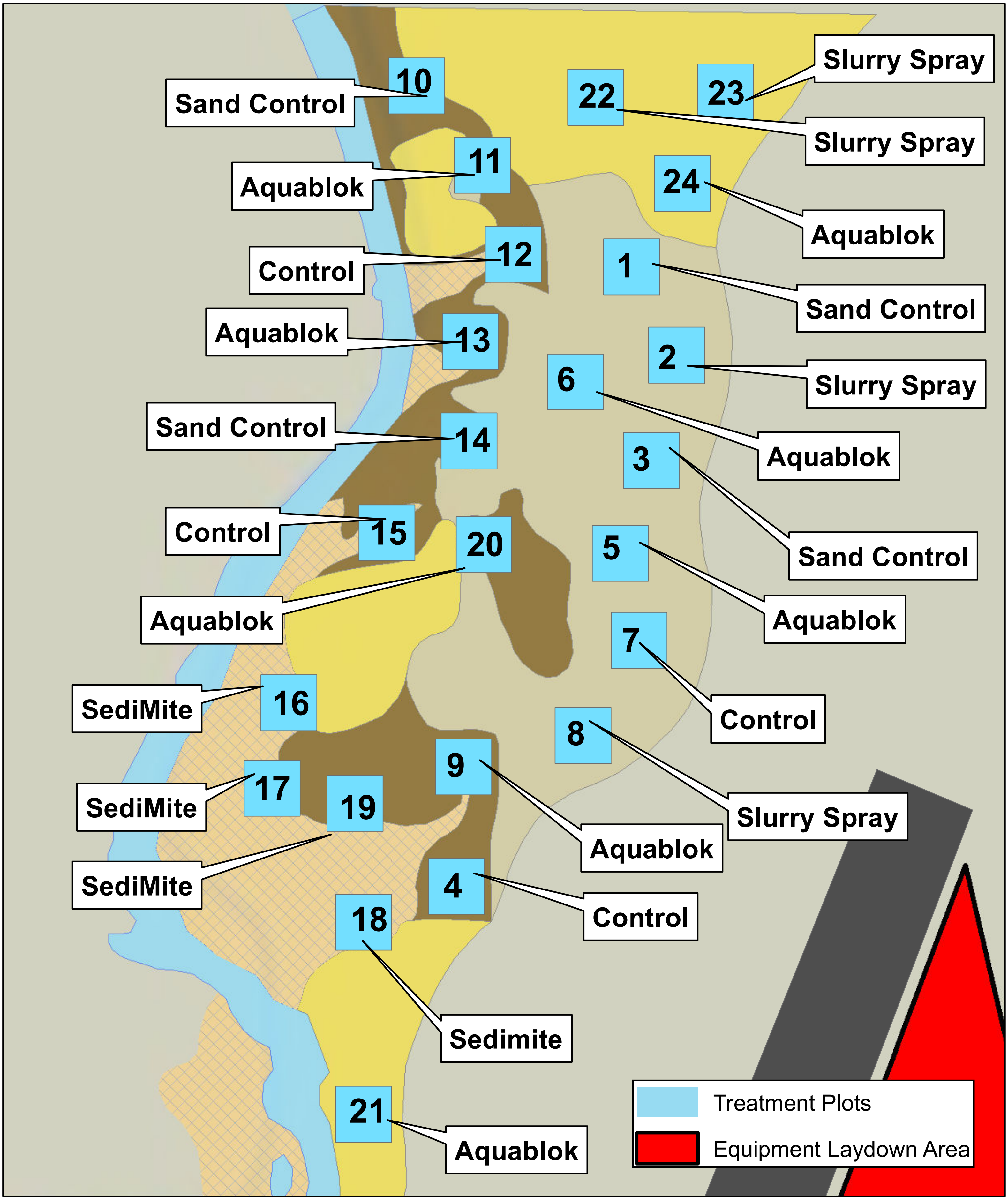


Figure 5-4
Treatment Plots and Laydown Areas
Aberdeen Proving Ground
Edgewood, MD

0 50 100 200 Feet

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5.6 FIELD TESTING

The field implementation was performed from November 29 through December 10, 2010. The initial phase of field work included set-up and mobilization. During the second phase of field work, the amendments were applied to the test plots. All equipment was removed from the site following placement of the amendments. Post-demonstration monitoring occurred six months and 12 months after amendment application. Monitoring methods are described in Section 5.7.

5.6.1 Demonstration Set-Up, Mobilization and Start-Up

Field equipment and supplies were mobilized to the demonstration site during the week of November 29, 2010. Field personnel were oriented to the site and were made aware of their specific duties and potential health and safety concerns. Site preparation activities included UXO clearance, decontamination and laydown area setup, delineation and set-up of treatment plots, receipt of materials and equipment used for placement of the amendment, and Time 0 sampling.

UXO clearance was performed by EA Engineering, Science, and Technology, Inc. (EA) during the week of November 29, 2010. UXO clearance was conducted using magnetometers and visual-manual methods. EA cleared the upland equipment laydown areas, marked off access paths (into the wetlands and within the wetlands), and cleared the plots themselves. Suspicious materials were investigated by EA personnel and removed from the work areas as necessary. Each team was accompanied by an EA representative for UXO clearance during plot installation and baseline characterization sampling. No suspected UXO were found.

As described in Section 5.4, test plots were installed, sediment control products placed and staked, temporary walkways deployed, and Time 0 sampling occurred after UXO clearance was complete. The 24 plots were established by the end of the day on November 30, 2010. Plot clearing and installation activities were photographed by an APG photographer (see Appendix A). One test plot (#15) had to be relocated from its planned position due to the presence of a United States Geological Survey (USGS) monitoring well inside the proposed plot area. The plot was relocated approximately 50 feet to the north, so that the monitoring well was no longer inside the plot, and the coordinates of the new plot corners were recorded.

Sediment control products (straw wattles) were delivered to the upland laydown area on pallets and moved to the wetland as needed. The wattles were transported to the wetlands by teams of two people, via a process designed to minimize impact to the wetland system while efficiently moving the wattles to the plots. Six to nine wattles were hauled by foot from the pallets and dragged on tarps to the plots per trip. Two people were able to move several wattles at one time, greatly reducing the number of trips into the wetland. The vegetation along the paths experienced minor, temporary flattening; however, the wetland soils were not compacted as the loaded tarps floated on the water once they entered the flooded wetland. Thus, the wetland system experienced significantly less disturbance than if heavy equipment was used. The southwest portions of the study area were inundated at times during plot layout. A photographic log of construction-related activities and post-construction marsh recovery is provided in Appendix A.

In order to prepare for placement of wattles, the vegetation along the plot perimeters was cut to grade using machetes and 30 inch, double-sided weed cutters. Wattles were placed around the boundary of each plot area and secured using wooden stakes. Senesced vegetation inside the plots was manually trimmed to approximately one foot above grade to facilitate amendment placement. All wattles were successfully installed by the end of day on December 2, 2010.

Time 0 sampling was conducted in general accordance with the approved field deployment plan. Samples were collected from (0-15 cm) in all plots on December 2 and 3, 2010.

5.6.2 Material Placement

Material placement activities occurred during the week of December 6, 2010. Material placement methods differed by sequestration agent, sequestration agent form, whether the material was placed subaqueous or on hydric soil, the desired layer thickness and precision, and field considerations (e.g., access). Material placement methods were selected to be scalable, non-or minimally invasive, and deployable to relatively remote areas. Further, the methods were selected to address the variable hydrologic conditions of the tidally-influenced wetland system. The equipment used for each amendment and wetland type is described below. The following amendment volumes were placed during the demonstration project:

- 26 tons of pelletized carbon as AquaBlok®;
- 2,560 pounds of SediMite™;
- 1,250 pounds of powdered activated carbon (PAC) via slurry system; and
- 12.5 tons of soil cover.

The thicknesses of amendment applications for each material are presented on Table 5-6.

Figure 5-5 Pelletized Carbon as AquaBlok®

Pelletized Activated Carbon Placement

Twenty-six tons of AquaBlok® (see Figure 5-5) was deployed to eight plots (APG-5, APG-6, APG-9, APG-11, APG-13, APG-20, APG-21, and APG-24) using a Finn Corporation model BB705 bark blower. AquaBlok® was delivered in 1.25 ton super-sacks on pallets and a forklift was used to lift the super-sacks above the receiving hopper of the bark-blower, where they were subsequently emptied. Each of the eight plots received approximately 3.3 tons of AquaBlok® (approximately 6,550 pounds). Each plot received 2.5 super-sacks of AquaBlok® deployed with the bark-blower, with an additional 300 pounds of AquaBlok® deployed manually via five gallon buckets to APG-21, APG -9, APG -20, APG -7, APG -11, and APG -24 to achieve desired mass loading of AC. Deployment of the AquaBlok® agent is summarized in Table 5-7.

SediMite™ was similarly broadcast as described in the *Field Documentation Work Plan* ESTCP Project No. ER-200835, July 2009. The details of deployment will be reported in the Final Report for Project No. ER-200835.

Table 5-6 Application Homogeneity

Plot ID, "APG-"	Treatment thickness (inches) by quadrant				Treatment
	NW	NE	SE	SW	
1	2	2.5	2	1	Sand control
2	NM	NM	NM	NM	Slurry Spray
3	2	1.5	2	2	Sand control
4	NA	NA	NA	NA	Control
5	2.5	3	2	3	AquaBlok®
6	1.5	1.5	2	3	AquaBlok®
7	NA	NA	NA	NA	Control
8	NM	NM	NM	NM	Slurry Spray
9	2	2	2	2.5	AquaBlok®
10	1.5	2.5	2	1.5	Sand control
11	3	1.5	1.5	2	AquaBlok®
12	NA	NA	NA	NA	Control Plot
13	2.5	1.5	1.5	2.5	AquaBlok®
14	ice	1.5	2.5	3	Sand control
15	NA	NA	NA	NA	Control
16	ice	ice	0.5	ice	SediMite™
17	0.5	0.5	0.5	0.5	SediMite™
18	ice	ice	ice	ice	SediMite™
19	0.5	0.5	ice	ice	SediMite™
20	2	1.5	2.5	2	AquaBlok®
21	2.5	2	.	1.5	AquaBlok®
22	NM	NM	NM	NM	Slurry Spray
23	NM	NM	NM	NM	Slurry Spray
24	2.5	3	2	2	AquaBlok®

NA = not applicable

NM = not measured/ thin veneer

Ice = amendment thickness could not be measured due to the presence of ice

Table 5-7 AquaBlok® Deployment Summary

		Test Plot ID							
		APG-21	**APG -05**	**APG -20**	**APG -09**	**APG -11**	**APG -24**	**APG -13**	**APG -06**
Deployment Metric	Pounds of AquaBlok® Deployed per Test Plot	6,225							
	Pounds per Hour	3,248	2,767	2,988	3,395	2,075	4,669	2,394	4,980
	Tons per Hour	1.62	1.38	1.49	1.70	1.04	2.33	1.20	2.49
	Effective Carbon Deployment Rate (pounds AC per hour)	162.4	138.3	149.4	169.8	103.8	233.4	119.7	249.0
		Length of Hose (LFT)							
		100	150	200					
Deployment Metric	Avg Tons per Hour	2.15	1.70	1.24					
	Avg Effective Carbon Deployment Rate (pounds activated carbon per hour)	214.94	169.77	124.29					

PAC Slurry Placement

The PAC was deployed to four plots (APG-2, APG-8, APG-22, and APG-23) using a FINN model T75 hydro-seeder with a 750 gallon tank capacity. Hydro-seeders are designed to rapidly apply slurries to large areas. They have an attached tank with mechanical agitators and/or re-circulating pumps that function to mix and keep the solids in suspension. Hydro-seeders range in size from small trailer mounted units to large truck mounted units. Hydro-seeders can reach significant distances from the pump, with typical hose lengths of 300 – 500 feet. They are generally limited to a solids percentage of less than 10%. The application rate of the slurry is limited by the amount of water that can be applied to the wetland soils before the slurry is no longer absorbed and begins to flow off the test plot. Depending on the saturation and hydraulic conductivity of the soil, multiple applications may be necessary to achieve the desired mass application rate.

Six hundred pounds of AC and approximately 180 to 200 gallons of water (total weight of approximately 1,500 to 1,700 pounds) were loaded into the tank of the hydro-seeder to form a 35-40% slurry by mass. The hydro-seeder agitator was then used to mix the slurry, and approximately half of the mixture was pumped to each plot. The application process was conducted in approximately 15 minutes for each plot, during which time an even coating of the slurry was applied over the entire plot.

Sand Mixture Placement

A sand mixture consisting of 90% sand and 10% organic rich topsoil was combined to create a manufactured soil cover amendment (referred to as the Sand control). The manufactured soil was deployed to four plots (APG-1, APG-3, APG-10, and APG-14) that served as control plots for

comparison to a natural soil cover application. Approximately 12.5 tons of the sand/top soil mixture was delivered to the staging area in bulk via a dump truck, stockpiled, and covered with polysheeting. The sand/top soil mixture was loaded into super-sacks on-site for measurement and to allow loading into the bark-blower hopper. The sand/top soil mixture moisture content was high, due to the rainy conditions during delivery, even though all possible efforts were taken to keep the mixture dry (i.e. covered with poly-sheeting). Each of the plots received approximately 3.1 tons of the sand mixture.

Sand was deployed successfully on APG-3 using the bark blower following the same application procedures as was used to place the AquaBlok®. However, the moisture content in the sand posed significant challenges. Due to the low air temperatures and high moisture content of the sand, the bark-blower clogged frequently and significantly. Approximately 2.15 tons was deployed to APG-10 using the bark blower before cold air temperatures rendered the bark blower inoperable. The remaining sand mixture (approximately 7.25 tons) was manually deployed via five gallon buckets. Table 5-8 summarizes the sand deployment rates. Implementability issues are summarized in Section 6.3.2.

Table 5-8 Sand Deployment Time Summary

		Test Plot ID			
		APG-3	**APG-14***	**APG-10***	**APG-1***
Deployment Metric	Pounds of Sand Deployed per Plot	6,250			
	Pounds per Hour	3,261	NA	NA	NA
	Tons per Hour	1.63	NA	NA	NA
	Effective Carbon Deployment Rate (Pounds activated carbon per hour)	32.6	NA	NA	NA
		Length of Hose (LFT)			
		100	150	200	
Deployment Metric	Avg Tons per Hour	1.63	NA	NA	
	Avg Effective Carbon Deployment Rate (Pounds activated carbon per hour)	32.61	NA	NA	

* Sand mixture freezing and clogging hose and bark-blower.
NA= Not applicable

Field Modifications

Field modifications from the Demonstration Plan were discussed prior to implementation and documented in daily field logs. The following changes were noted:

- APG-15 was relocated as described above from the location proposed in the Demonstration Plan due to the presence of a USGS groundwater monitoring well within the plot.

- APG-15 was proposed to receive the AquaBlok® treatment; however, it was changed to a control plot and APG-20 was switched from a control to an AquaBlok® plot due to the distance of APG-15 exceeding 250 feet from the equipment.

The method of sand deployment was modified December 10th due to freezing of the wet sand/top soil mixture in the bark blower and broken shear pins in the conveyor belt track, rendering the equipment unusable. As a result, the manufactured soil mixture was delivered and spread in control plots APG-14, APG-10, and APG-1 by hand using 5-gallon buckets.

5.6.3 Demobilization

After completing material placement, the deployment equipment was demobilized. The unused straw wattles were cut up and placed over disturbed areas to provide erosion protection. All trash was properly disposed of in an on-site dumpster.

A series of cores (one foot or 30 cm) was collected from eight plots on December 10 via a hand driven push core. This subset of the deployment plots (APG-2, APG-8, APG-10, APG-13, APG-14, APG-17, APG-19, and APG-20) was selected to provide a cross-sectional representation of post-deployment wetland substrates. Cores were photographed and then archived at the UNH laboratory.

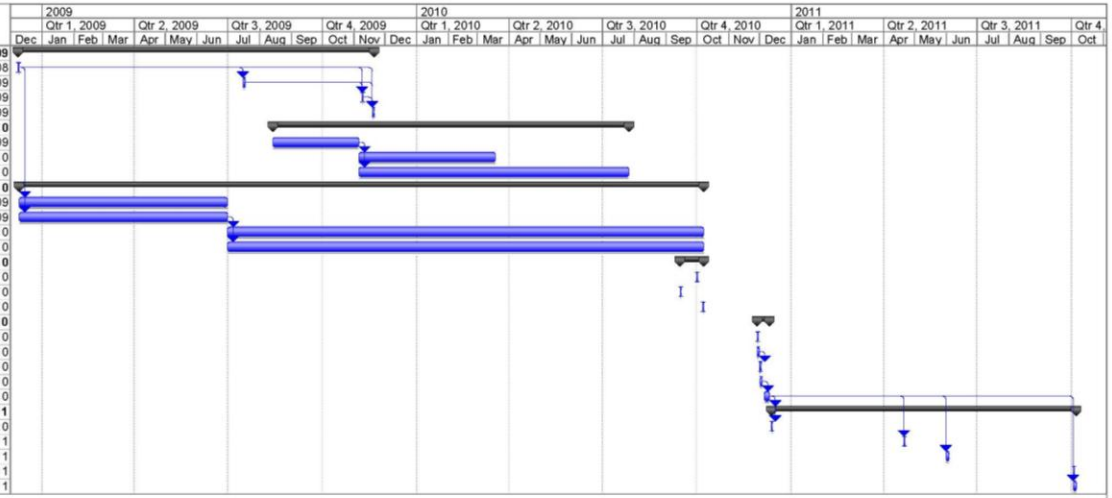
Five drums of properly labeled decontamination waste (four drums contained decontamination water and one contained PPE) were stored on-site for waste characterization sampling. The drums were sampled on January 28, 2011. A water sample and a personal protective equipment (PPE) sample were submitted to Katahdin Analytical Services (Portland, Maine) for PCBs (SW 8082) and Pesticides (SW8081). Upon receipt of the data, the APG waste contractor was able to properly remove the drums from the site for appropriate off-site disposal.

5.6.4 Field Demonstration Schedule

Figure 5-6 presents the schedule of activities related to the field implementation of the technology. Post-treatment monitoring activities and scheduling are described in Section 5.7.

Figure 5-6 Field Demonstration Schedule

ID	Task Name	Duration	Start	Finish
1	**Initial Site Acitivities**	**249 days**	**Tue 12/9/08**	**Fri 11/20/09**
2	Site Visit	1 day	Tue 12/9/08	Tue 12/9/08
3	Screening Characterization	2 days	Thu 7/16/09	Fri 7/17/09
4	Weltand Delineation	1 day	Mon 11/9/09	Mon 11/9/09
5	Nature and Extent Characterization	2 days	Thu 11/19/09	Fri 11/20/09
6	**Permitting**	**247 days**	**Fri 8/14/09**	**Mon 7/26/10**
7	State Wetland Permit Application	60 days	Fri 8/14/09	Thu 11/5/09
8	USACE Determination	95 days	Fri 11/6/09	Thu 3/18/10
9	MD Board of Public Works Wetlands Division	187 days	Fri 11/6/09	Mon 7/26/10
10	**Work Plans**	**477 days**	**Wed 12/10/08**	**Thu 10/7/10**
11	Sampling Health and Safety	145 days	Wed 12/10/08	Tue 6/30/09
12	Sampling Plan	145 days	Wed 12/10/08	Tue 6/30/09
13	Field Demonstration Health and Safety	332 days	Wed 7/1/09	Thu 10/7/10
14	Field Demonstration Sampling Plan	332 days	Wed 7/1/09	Thu 10/7/10
15	**Prefield Activities**	**17 days**	**Wed 9/15/10**	**Thu 10/7/10**
16	Subcontractors arranged	1 day	Fri 10/1/10	Fri 10/1/10
17	Amendment materials ordered	1 day	Wed 9/15/10	Wed 9/15/10
18	Material Delivery Schedule Finalized	1 day	Thu 10/7/10	Thu 10/7/10
19	**Field Demonstration**	**10 days**	**Mon 11/29/10**	**Fri 12/10/10**
20	UXO Clearance	1 day	Mon 11/29/10	Mon 11/29/10
21	Test Plots Established	2 days	Mon 11/29/10	Tue 11/30/10
22	Sediment Control Measures Installed	2 days	Wed 12/1/10	Thu 12/2/10
23	Time 0 Baseline Characterization	2 days	Thu 12/2/10	Fri 12/3/10
24	Treatment Placement	5 days	Mon 12/6/10	Fri 12/10/10
25	**Post-Implementation Monitoring**	**213 days**	**Mon 12/13/10**	**Wed 10/5/11**
26	Hydric Soil Core Collection	1 day	Mon 12/13/10	Mon 12/13/10
27	Passive Pore Water Samplers Installed	1 day	Thu 4/21/11	Thu 4/21/11
28	Time 1 Monitoring	3 days	Wed 6/1/11	Fri 6/3/11
29	Passive Pore Water Samplers Retrieved	1 day	Mon 10/3/11	Mon 10/3/11
30	Time 2 Monitoring	3 days	Mon 10/3/11	Wed 10/5/11



Project: InSitu Wetland Restoration De
Date: Tue 3/26/13

Task	Milestone	Rolled Up Task	Rolled Up Progress	External Tasks	Group By Summary
Progress	Summary	Rolled Up Milestone	Split	Project Summary	Deadline

5.7 SAMPLING METHODS

Treatment effectiveness of the *in situ* wetland remediation technology was evaluated through the monitoring program described in this section. Time 0 baseline characterization sampling programs were performed in November 2009 and December 2010 prior to field deployment of the amendments. Post-treatment monitoring was performed 6 months (Time 1) and 10 months (Time 2) after amendment application.

The Time 1 post-treatment monitoring was performed in June 2011 and Time 2 monitoring was performed in October 2011 to allow for monitoring during peak growing season foliage conditions (i.e., between approximately March and October of the year). Monitoring tasks included field sample collection, chemical analyses, laboratory bioaccumulation testing, and ecological evaluations to assess the efficacy of the sequestration agent application, and the wetland community response to implementation of the *in situ* treatment. The number and types of samples collected and the analytical methods that were used are presented in Tables 5-9 and 5-10, respectively. Identical sampling techniques, field observations, and laboratory analysis methods were used during each sampling event, and within each sampling plot. Field sample collection is described in Section 5.7.1, methods for analysis of the chemical data are discussed in Section 5.7.2, and ecological methods are described in Section 5.7.3.

5.7.1 Hydric Soil Sample Collection

Hydric soil samples were collected for chemical and physical characterization purposes from within each test plot for each sampling event. One representative sample was collected per test plot; the representative sample was a composite of eight sub-samples collected from the upper 0-6 inches (0 to 15 cm) of the soil profile using a hand soil auger. Figure 5-7 depicts a typical Time 0 soil profile observed by splitting a soil core. The eight sub-composite soil samples were placed in a stainless steel bowl, homogenized, and composited following standard USEPA sediment sampling methods (USEPA, 2001). Composited hydric soil samples were shipped to UNH where they were split for *ex situ* pore water and bulk soil analysis.

Figure 5-7 Soil Core Collected from APG-08 at Time 0. Photographic scale is in inches.

Hydric soil samples were collected from two replicate treatment plots for bioaccumulation analysis. Samples were collected and composited as described above, all but two composite samples were combined from two different plots that contained the same amendment treatment. Composite sampling was conducted in order to acquire enough soil mass from each treatment type to support the 28-day bioaccumulation study with laboratory-supplied polychaetes. Composited samples were shipped to biological laboratories for testing (either Aquatic Biological

Sciences [Burlington, Vermont] or AECOM Fort Collins Environmental Toxicology Laboratory [Fort Collins, Colorado]) where 28-day bioaccumulation tests were conducted with *L. variegatus* (USEPA, 2000) Following bioaccumulation testing, the collected receptor tissue samples were subsequently shipped to UNH for chemical analysis. A sub-sample of the composite hydric soils was also shipped to UNH for pore water and bulk soil analysis.

In addition to the composite soil samples, a second set of soil cores was collected. One representative 0 to 30 cm intact core sample was collected per plot and archived from the Time 1 and Time 2 sampling events for potential future PCB analysis should funding become available for analysis of multiple sampling horizons within the core.

Twenty *in situ* passive pore water samplers were deployed in April 2011 to provide a second method to evaluated PCB pore water concentrations following amendment application. The samplers were deployed through October 2011.

Table 5-9 Analytical Methods for Sample Analysis

Matrix/ Parameter	Test Description	Sampling Method	Analytical Method
Pore Water			
PCBs	*Ex situ* POM passive sampling	Hawthorne et al., 2009	Modified EPA 8072[1]
PCBs	*In situ* PED passive sampling	Adams et al., 2007	Modified EPA 8072[1]
Hydric Soil			
Grain size	Grain size analysis	ASTM D 422	NA
Moisture content	Thermal volatilization	Gustafsson et al., 1997	NA
NOM	Thermal oxidation	Gustafsson et al., 1997	NA
Black Carbon	CTO organic carbon analysis	Grossman & Ghosh, 2009	NA
PCBs	Accelerated solvent extraction	EPA 8082A	Modified EPA 8072[1]
Tissue			
PCBs	28 day bioaccumulation testing; Accelerated solvent extraction	EPA 600/R-99/064; EPA 8082A	Modified EPA 8072[1]

[1] Congener specific analysis representing 99% of total PCBs

CTO = Chemical Thermal Oxidation

NA = Not Applicable

5.7.2 Physical and Chemical Sampling and Analysis

Wetland soil samples were collected and submitted for physical and chemical laboratory testing. Physical parameters evaluated include soil texture analysis (i.e., grain size), soil organic content, black carbon content and percent moisture. Chemical analysis of PCBs in bulk soil, pore water, and macroinvertebrate tissue was conducted to assess the bioavailable fraction of PCBs and the resultant efficacy of the applied treatments.

Hydric Soil General Characterization Methods

Bulk hydric soil moisture contents were established by drying the hydric soil at 60°C for 48 hours (Gustafsson et al., 1997). Concentrations are reported as mass water per total bulk hydric soil. Natural organic carbon was also measured thermogravimetrically (Gustafsson et al., 1997). Dry samples were combusted at 375°C for 24 hours in the presence of oxygen. Black carbon was measured through a chemical thermal oxidation procedure (Grossman and Ghosh, 2009). Grain size analysis was conducted by GeoTesting Express in accordance with ASTM D422-63. All hydric soils samples were homogenized prior to analysis.

Bulk Hydric Soil PCB Extraction and Sample Preparation

Hydric soil samples were evaluated for bulk PCB concentrations following a modified EPA 8082A using GC/MS. Approximately 10 grams of composite samples was chemically dried with sodium sulfate. The samples were extracted within stainless steel accelerated solvent extraction (ASE) cells on a Dionex ASE 200 Accelerated Solvent Extractor with a 1:1 Hexane/Acetone mixture at 100°C and 1,500 psi (pounds per square inch). Following extraction, the solvent extract was concentrated to 5 milliliters (ml) under nitrogen. Excess water was removed during this process chemically with sodium sulfate. A size partitioning exclusion clean up method using Thermo Scientific HyperSep Si Packs was then applied to the samples to remove interfering compounds (EPA 3630C). The solvent extract was then again reduced under nitrogen and concentrated to 10 ml in hexane. The final extracts were transferred to 16 ml amber vials until GC/MS analysis was conducted.

Pore Water PCB Extraction and Sample Preparation

Collected sediment grab samples were evaluated for their PCB concentration in the pore water phase using Polyoxymethylene (POM) passive samplers (Hawthorne et al., 2009). The strips of POM were cut into 4x6 cm pieces and sonicated for three hours in methylene chloride followed by immersion for three hours in methanol. The POM strips were then rinsed in reverse osmosis (RO) water and air dried in a fume hood on clean tinfoil for less than 1 hour. POM strips that were not immediately used were stored in RO water. Twenty grams of homogenized sediment was added to a muffled 60 ml amber vial along with one strip of POM and 40 ml of a 50 mg/ml sodium azide solution. POM strips were weighed prior to insertion into the vials. The sample vials were then capped and shaken for five seconds. Samples were placed on a rotator wheel for a 28 day equilibrium period. At the conclusion of this equilibrium time, the POM strip was removed from the sample vials and rinsed for 15 seconds using RO water and extracted in 40 ml of a 1:1 hexane/acetone solution. The extract was concentrated under nitrogen to 10 ml and transferred to 16 ml amber vials until analysis (Modified EPA 8082A). Pore water concentrations were determined from the POM according to published POM-pore water partitioning coefficients (Hawthorne et al., 2009).

In Situ Pore Water PCB Extraction and Sample Preparation

Pore water concentrations were also sampled *in situ* with Polyethylene Devices (PEDs) consistent with the methodology described in Adams et al. (2009). Twenty 15 inch by 12 inch PED frames, with approximately a 6 inch by 12 inch exposed section of PE in the center, were deployed in December 2010 and left to equilibrate with the *in situ* pore water for 10 months in 20 of the treatment plots. Samplers were installed so that the PE (polyethylene) was exposed to the top six inches of sediment, to evaluate the pore water concentrations with vertical depth (profile). In October, 2011 the samplers were recovered from the field. The polyethylene sheeting was immediately rinsed with RO water by field personnel to remove any soil/debris. The top two inches of PE (exposed to the top 2 inches of soil) was cut from the frame, followed by the next 2 inches (exposed to the -2 to -4 inch layer of soil) and lastly the bottom two inches of exposed PE (exposed to the -4 inch to -6 inch layer of soil). As each section was removed, it was placed in a 40 ml volatile organic analysis (VOA) vial. A 1:1 Hexane/Acetone mixture was later added to extract the PE. Samples were then shipped to UNH laboratories for analysis.

Upon arrival, each sample vial was inspected and sonicated for 2 hours (Adams et al., 2009). The solvent extracts were then removed from each vial, exchanged to hexane and concentrated to 10 ml. Samples were transferred to 16 ml amber vials and stored at 4°C until analysis.

Macroinvertebrate Tissue PCB Extraction and Sample Preparation

Bioaccumulation studies were conducted in the laboratory with composite hydric soil samples from multiple plots containing the same treatment. Soils were shipped directly to biological laboratories for the 28 day bioaccumulation testing using *L. variegatus* following EPA/600/R-99/064. After the conclusion of the exposure period, the guts of the organisms were purged, the organisms were blotted dry, weighed and frozen in a 20 ml vial. Vials were shipped overnight on ice to UNH laboratories for chemical analysis.

Upon receipt, samples were masticated in sodium sulfate and Ottawa sand, then extracted on a Dionex ASE 200 Accelerated Solvent Extractor (EPA 8082A) with a 1:1 Hexane/Acetone mixture at 100°C and 1,500 psi. Following extraction, the solvent extract was concentrated to 5 ml under nitrogen. Excess water was removed during this process chemically with sodium sulfate. A size partitioning exclusion clean up method using Thermo Scientific HyperSep Si Packs was then applied to the samples to remove interfering compounds (EPA 3630C). The solvent extract was then again reduced under nitrogen and concentrated to 10 ml in hexane. The final extracts were transferred to 16 ml amber vials until PCB analysis via GC/MS was conducted.

Due to tissue mass limitations, only PCB analysis was conducted on tissue samples; no sampling for lipids was possible.

PCB Analysis by Gas Chromatography/Mass Spectroscopy

Two PCB analyses were conducted within this study following a congener specific modified EPA 8072 method. Preliminary qualitative analyses were conducted to determine the major contributing congeners present at the site; a second analysis was conducted to quantify the concentration of the major congeners within the bulk hydric soil, pore water, and macroinvertebrate tissue. A 209 Congener PCB standard manufactured by AccuStandard (New Haven, CT) was used for the qualitative analysis. A 30 congener PCB standard, custom fabricated

at UNH from individual congener standards distributed by AccuStandard was used in dilution for the quantitative study. The standard accounted for 29 of the congeners found in the qualitative study in addition to a surrogate standard. The quantitative standard accounts for >99% of the total PCB mass observed in the qualitative study. Both analyses were conducted on a Varian CP3800 GC/Saturn 2200 MS. One microliter (µL) of sample was injected onto a DB-5 type capillary column (Varian Factor Four VF-5ms), ionized via electromagnetic ionization and detected with selective monitoring ion trap technology.

PCB Data Handling and Statistical Methods

PCB concentrations in this study are reported as total PCBs (cumulative sum of the 30 congener standard). Total PCBs were measured following a modification of EPA's method 8082A: Polychlorinated Biphenyls (PCBs) by GC/MS (in place of GC/ECD). Under this methodology, the concentration of PCBs measured as Aroclors or as individual PCB congeners may be determined in extracts from solid, tissue, and aqueous matrices. The holding time depends on what matrix it comes from; congener-specific PCBs from a pore water matrix are held 7 days to extraction and 40 days from extraction to analysis, whereas total PCBs in a tissue matrix are held for twice the length of time to extraction. Standard statistical evaluations of the concentrations including ANOVA and t-tests were also applied when appropriate. ANOVA was used to determine significant variance relative to the control and t-tests were used for comparison evaluations to identify which components were statistically significantly different between pre- and post- treatment. Statistical significance was determined at the alpha = 0.05 level and evaluations were performed using JMP Pro 10.0 Statistical software.

5.7.3 Ecological Monitoring

Ecological monitoring included the quantitative assessment of the physical characteristics, plant communities, and benthic invertebrate communities within each plot. Identical parameters (Table 5-10) were measured in both the lower quality *Phragmites* dominated system (low value wetland) and the more diverse high value freshwater marsh system (high value wetland). Ecological observations were compared to data collected prior to the application of amendments and to concurrently monitored control plots. Control plots with the same vegetation, soils, and hydrological conditions were incorporated and monitored in parallel.

Table 5-10 Ecological Monitoring Field Measurements

<table>
<tr><th>Field Activity</th><th>Subject of Monitoring</th><th>Measurement</th><th>Comments</th></tr>
<tr><td rowspan="4">Time 0 Baseline Characterization</td><td>Soil characteristics</td><td>Texture, TOC</td><td></td></tr>
<tr><td rowspan="3">Resident plants</td><td>Abundance/Density</td><td>Number of individual emergent plants per square meter</td></tr>
<tr><td>Species diversity</td><td>Plants identified to lowest practical taxon (typically species)</td></tr>
<tr><td>Percent areal coverage</td><td>Measured for separate strata</td></tr>
</table>

Table 5-10 Ecological Monitoring Field Measurements (con't)

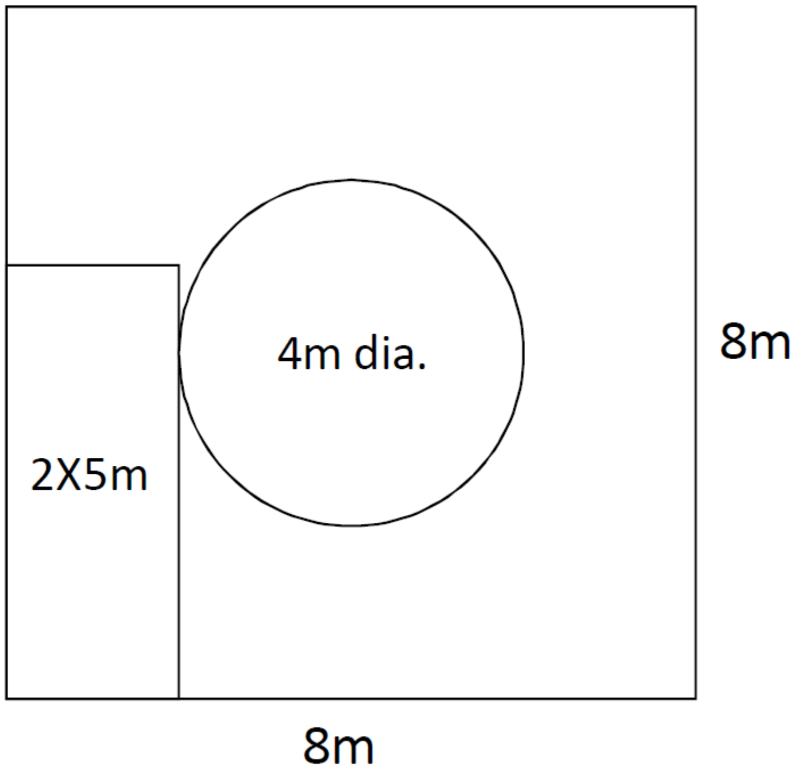
Field Activity	Subject of Monitoring	Measurement	Comments
Time 0 Baseline Characterization	Invasive exotic plants	Presence and number	Plants identified to lowest practical taxon (typically species) Estimate of distribution and square footage per occurrence
Time 1 Post-treatment monitoring	Same as Time 0	Same as Time 0	Same as Time 0
	Benthic invertebrates	Abundance and diversity of benthic invertebrates	Invertebrates identified to lowest practical taxon in the field
Time 2 Post-treatment monitoring	Same as Time 1	Same as Time 1	Same as Time 1

Vegetation Monitoring

Vegetation monitoring included an evaluation of survivorship and health of resident plants measured as total percent cover, species richness, and diversity (i.e., Shannon-Wiener Diversity Index) for the layers present (i.e., herbs, shrubs/saplings, vines and/or trees). Diversity indices are useful because they take into account both species richness and the relative abundance of each species to quantify how well species are represented within a community. Invasive plant species were also documented, in terms of percent cover within each sample plot, and dense mono-culture stands were mapped throughout the field demonstration wetland on aerial photographs with lateral extents confirmed in the field. Monitoring was conducted both pre- and post-application to assess plant community health including documentation of early senescence, yellowing or stunting of vegetation during post-treatment sampling events. Plants were identified to species level, and percent cover was estimated using a modified Daubenmire cover class system (Daubenmire, 1959).

To accomplish this task efficiently, sub-plots (one rectangular and one circular) were placed within each of the 8 meter by 8 meter treatment plots. Rectangular plots were used because when placed parallel to the stream channel, encompass more heterogeneity and recover greater species richness than round or square plots, and because vegetation cover alone is the important metric, plot size is not a factor (Barbour et al., 1999). Therefore, relatively small 10 m^2 (2 x 5 m) plots that can be easily sampled by one plant biologist were placed in the southeastern corner of each 8 meter by 8 meter treatment plot (Figure 5-8). Circular (4-meter diameter) plots were placed at the center of each treatment plot to ensure good representation of conditions within each treatment plot. Additional vegetation survey information is available in Appendix E.

Figure 5-8 Daubenmire Cover Class System



Range of Cover (%)	Midpoint (%)
<1	0.5
1-5	3.0
6-15	10.5
16-25	20.5
26-50	38.0
51-75	63.0
76-95	85.5
96-100	98.0

Plant Nutrient Study

A plant nutrient study was conducted by exposing Japanese millet (*Echinochloa crusgalli*) plant seedlings to soil samples (one foot / 30 cm cores) collected from three treatment plots (APG-02 Slurry Spray, APG-06 AquaBlok®, APG-16 SediMite™), an un-treated plot (APG-15 Site Control), and a laboratory control soil. Testing was conducted by the AECOM Fort Collins Environmental Toxicology Laboratory in Fort Collins, Colorado. Seedlings were planted in containers containing homogenized hydric soil collected at Time 1 (approximately 6 months post-application), hydrated with deionized (DI) water, and incubated at standardized temperature, lighting and humidity conditions. A nutrient solution was added to each test chamber to ensure adequate growth during the study. The duration of the study (77 days) was designed to ensure adequate plant material for nutrient / mineral analyses by the analytical laboratory.

At test termination, the number of surviving plants was recorded in all the test chambers. Surviving plants were gently removed from the hydric soil without damaging the plant. Shoot biomass was separated from root biomass by cutting the plant in two at the hypocotyl-radicle junction. All shoot biomass (plant) was rinsed to remove extraneous sediment on the plant. The length of each shoot was measured from the base to the extent of the longest leaf. All shoots from a replicate were combined into a tared aluminum pan and measured for wet weight (± 0.1 mg) and then dry weight after shoots were dried at approximately 85˚C for a minimum of 24 hours. Hydric soils from all replicates within a treatment were pooled to produce a single analytical sample for each treatment. Soil samples were analyzed by Columbia Analytical Service (CAS) labs for boron,

calcium, copper, iron, magnesium, manganese, phosphorous, potassium, sodium, sulfur and zinc. Dried plants (after biomass and length determination) for individual replicates were submitted to CAS labs for nutrient / mineral analyses for the same inorganic analytes. Uptake factors were calculated by dividing the plant tissue concentrations by the soil analytical results.

Statistics were conducted on the results of the plant health metrics (e.g. shoot length, root weight, biomass), plant tissue concentrations, and uptake factors relative to the laboratory control and the untreated plot (APG-15 Site Control) results. The laboratory report including details of the test and statistical methods is included as Appendix G.

Macroinvertebrate Sampling

The benthic community monitoring was conducted according to EPA Rapid Bioassessment Protocols for Use in Wadeable Streams and Rivers (Barbour, et al. 1999). Rapid Bioassessment Protocol (RBP) II which generates limited data, is useful for screening potentially impacted areas and was used to evaluate changes between controls and test plots and between test plots. The RBP II was performed by a biologist in the field to assess changes in the richness of the benthic macroinvertebrate community using field taxonomy.

Soil core samples were collected and shipped to Watershed Assessment Associates [WAA] (Schenectady, NY). Both the high and low value wetlands within the treatment area were evaluated to determine the benthic macroinvertebrate community structure within 8' x 8' reference and treatment plots (APG-01 to APG-24). Replicate benthic macroinvertebrate samples were collected from each plot using a 3 inch diameter sediment coring device with 5 to7 inches of substrate penetration. The two post-treatment replicate samples were sent to WAA for benthic macroinvertebrate sample processing including identification and enumeration. The laboratory report including methods is included as Appendix F.

5.8 SAMPLING RESULTS

Analytical, field measurements and laboratory results are summarized below. Because the objective of this ESTCP demonstration data is not to make enforcement decisions under a regulated program, but is to assess performance of a technology, the following data analysis decisions were made: (a) the results of non-detect data were reported as 0; (b) detectable concentrations that were below the reporting limit were reported as measured; and (c) concentrations above the reporting limit were reported as measured. The statistical evaluation approach presented in Section 6 is consistent with Helsel (2012) and USEPA's ProUCL User's Guide (2010), which presents the uncertainty with use of 1/2 the reporting limit substitution.

5.8.1 Hydric Soil General Characterization

Soil cores were qualitatively evaluated for evidence of AC mixing in the vertical soil profile. Photographs of soils cores collected at Time 0 and Time 2 are shown in Appendix A. Time 2 cores were not fully split for soil characterization; thus, the description of AC mixing is not rigorous. The following general observations were made:

- The depth of PAC slurry mixing, when apparent, was limited to the top 2 inches of soil. PAC slurry was not readily observed in all cores suggesting potential migration prior to vertical mixing.

- AC desorbed from AquaBlok® aggregates and downward migration of AC in the soil profile and along roots is evident in several cores. The depth of vertical mixing varied but in several cores appears to have reached a depth of 3 or more inches.
- Evidence of AC was not readily visible in all SediMite™ cores but it was observed to be present and vertical mixing was apparent in some cores. The pellet delivery system was not apparent in photographs so the degree to which AC may have been desorbed from the pellet delivery system could not be estimated.
- Sand control cover exhibited little to no mixing and forms an apparent thin layer cap on the soil surface, which in a couple of instances was buried by fresh deposition.
- Iron oxide coatings were prevalent in the Time 2 cores, including the Control, but absent in Time 0 cores, suggesting a change in soil hydrologic conditions, possibly seasonal. The degree to which seasonal or event hydrologic changes may influence AC mixing or partitioning processes (such as residence time) is a data gap.

Figure 5-9 shows one representative core from each treatment type. Appendix A includes photos for all cores that were photographed.

Figure 5-9 Representative Soil Cores Collected at Time 2

Core 1 AC Slurry at APG-23. AC vertically well mixed in top 2 inches.

Core 2 AquaBlok(R) at APG-13. AC appears well mixed to 2 to 3 inches depth with infiltration to bottom of core along rhizome macropores.

Figure 5-9 continued Representative Soil Cores Collected at Time 2

Core 3 SediMite™ at APG-17. AC appears to have migrated along macropores to 3 to 4 inches depth.

Core 4 Sand/soil Control at APG-01. Fresh deposition above the sand.

Core 5 Control at APG-07.

Several general laboratory tests were conducted on selected hydric soil samples collected from depths of 0 to 15 cm (0 to 6 inches) to provide a characterization of the field site. General tests included moisture content, natural organic carbon (NOC), black carbon (BC), TOC, and grain size analysis. A summary of the results is included below; more detailed results are provided in Appendix B and Appendix D. The moisture content was determined for sediment samples from each test plot (APG-01 through APG-24) within the field site for all three monitoring events (n=72; Time 0, Time 1, and Time 2). The average moisture content was 61.9% with a standard deviation of 9.4%. The maximum moisture content observed was 76.9% and minimum was 36.2% (moisture content is reported per total (wet) weight).

Natural organic carbon (NOC) testing was conducted for each test plot within the field site during each monitoring event (n=72). NOC was measured by a thermogravimetric method according Gustafsson et al., 1997. This method isolates natural organic carbon from the black carbon in the samples; therefore activated carbon is not represented in these results. The average NOC observed on the site was 17.3% with a standard deviation of 0.56%. The maximum NOC observed was 31.2% and minimum was 4.2% (NOC is reported mass per unit dry soil mass).

A grain size analysis was conducted by GeoTesting (Acton, MA) in accordance with ASTM method D422-63. Ten composite samples from the Time 0 (12/2010) sampling event were evaluated. All samples were classified as a silty soil with the majority of mass within the silt/clay grain size fraction. No cobble sized grains were observed and the gravel fractions of the samples were below 0.5%. The remainder of the mass was within the sand fraction. Results of the hydric soil classifications are included in Table 5-12.

Table 5-11 Hydric Soil Characterization

Metric	N	Average	Standard Deviation	Maximum	Minimum
Percent Moisture Content	72	61.9%	9.4%	76.9%	36.2%
Percent Natural Organic Carbon	72	17.3%	0.56%	31.2%	4.2%
Soil Grain Size Fraction	10				
% Gravel		0.08%	0.11%	0.30%	0.00%
% Sand		22.3%	8.71%	40.0%	11.6%
% Silt/Clay		77.6%	8.70%	88.4%	60.0%

5.8.2 Black Carbon Assessment

Black carbon (BC) testing was conducted on surface soil samples for each test plot during each monitoring event (n=72) to evaluate the application of activated carbon in the treatment cells. BC results are shown as the average percent carbon by treatment (plus one standard deviation) on Figure 5-10. BC was measured by a chemical thermal oxidation method following Grossman and Ghosh (2009). This method removes the NOC fraction with chemical oxidation and measures the

remaining black carbon via CHN analysis. Average BC concentrations at the testing site prior to treatment application were 1.13% with a fairly large standard deviation (0.62%). On average, BC concentrations increased from the pre-treatment values at the 6 and 10 month monitoring periods within the plots containing treatment. BC concentrations in the control plots post-treatment remained relatively stable (Figure 5-10). Table 5-12 outlines the individual replicate measures, mean used and standard deviation in further detail and Table 5-13 summarizes the ANOVA analysis results between pre- and post-treatment within each treatment type.

Within the treatment plots, AquaBlok® was observed to have the highest BC concentration at the 6 month sampling event (avg=3.26% (SD=0.78%)), followed closely by SediMite™ (avg. = 3.24% (1.21%)), and then Slurry Spray (avg. = 2.59% (SD = 1.81%)). At the 10 month sampling, the trend was reversed, Slurry Spray plots were observed to have the highest carbon content (avg. = 2.03% (SD = 0.25%)), followed by AquaBlok® (avg. = 1.86% (SD = 0.75%)) and then SediMite™ (avg. = 1.36% (SD = 0.27%)). Although the overall carbon concentration increased as a result of treatment application, the similar concentrations among treatments and between post-treatment monitoring events do not indicate a significant difference in treatment technology permanence or performance. Additional sampling and evaluation would be required to adequately address the natural mixing and transport of treatment products in the environment. Slurry Spray and AquaBlok® were the only treatments whose percent-black carbon concentrations between pre- and post-treatment were significantly different; SediMite™ and the Sand control were determined to not be significantly different.

Figure 5-10 Black Carbon Concentrations

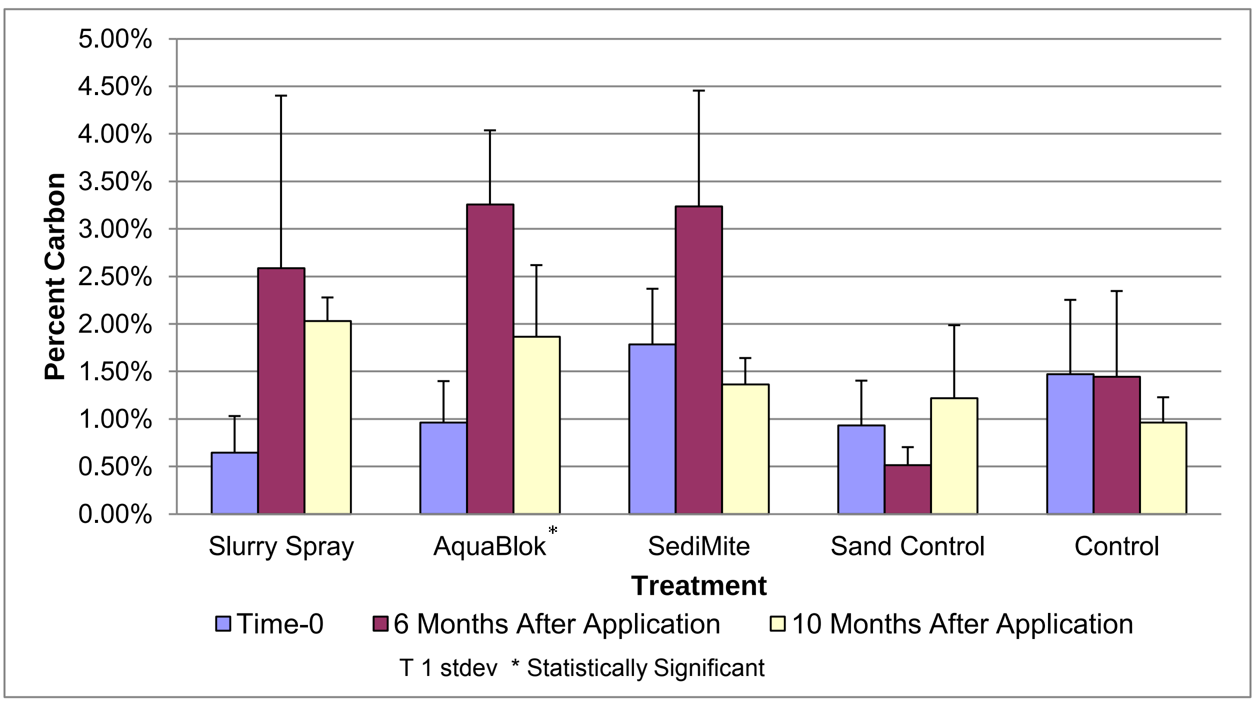


Table 5-12 Black Carbon Percentages

Treatment	Sample	Time 0 December 2010	Time 1 June 2011	Time 2 October 2011
Slurry Spray	APG-02	0.67%	1.18%	2.16%
	APG-08	0.37%	0.88%	2.28%
	APG-22	1.18%	3.88%	1.72%
	APG-23	0.37%	4.40%	1.97%
	Mean	**0.65%**	**2.59%**	**2.03%**
	Std. Dev	**0.38%**	**1.81%**	**0.24%**
AquaBlok®	APG-05	0.51%	2.57%	2.43%
	APG-09	1.25%	2.56%	2.82%
	APG-11	1.10%	4.87%	2.20%
	APG-13	1.23%	3.43%	2.05%
	APG-06	0.20%	2.66%	0.32%
	APG-24	0.72%	3.14%	1.86%
	APG-20	1.33%	3.76%	1.79%
	APG-21	1.37%	3.07%	1.44%
	Mean	**0.96%**	**3.26%**	**1.86%**
	Std. Dev	**0.43%**	**0.78%**	**0.75%**
SediMite™	APG-16	1.32%	3.83%	1.47%
	APG-17	2.45%	2.94%	1.44%
	APG-18	2.10%	4.50%	1.58%
	APG-19	1.27%	1.69%	0.96%
	Mean	**1.79%**	**3.24%**	**1.36%**
	Std. Dev	**0.58%**	**1.21%**	**0.28%**
Sand Control	APG-01	1.22%	0.43%	1.38%
	APG-03	0.37%	0.47%	0.38%
	APG-10	1.40%	0.37%	1.89%
	APG-14	0.74%	0.79%	Not Measured
	Mean	**0.93%**	**0.52%**	**1.22%**
	Std. Dev	**0.47%**	**0.19%**	**0.77%**
Control	APG-04	1.20%	1.51%	1.07%
	APG-07	0.73%	0.76%	0.66%
	APG-12	2.56%	2.69%	Not Measured
	APG-15	1.39%	0.82%	1.15%
	Mean	**1.47%**	**1.45%**	**0.96%**
	Std. Dev	**0.78%**	**0.90%**	**0.26%**

Black carbon percentages are dry weight-based relative to the total sediment sample mass.

Table 5-13 ANOVA Analysis Between Pre-and Post-Treatment Within Each Treatment

Treatment	F Ratio	Probability (>*p*)	Significant Variance
Slurry Spray	6.6420	0.0275	Yes
AquaBlok®	17.4045	0.0004	Yes
SediMite™	0.5595	0.4717	No
Sand Control	0.1137	0.7437	No

5.8.3 PCB Chemical Assessment

Composite hydric soil samples were collected for PCB characterization within the bulk phase, pore water phase, and tissue of benthic organisms exposed to the sediment. Samples were collected from 24 treatment plots within the treatment area over 3 sampling events in 2010 and 2011 to evaluate the effects of the treatments over time.

Bulk Hydric Soil PCB Concentrations

Bulk hydric soil samples had a wide range in PCB concentration (over 4 orders of magnitude) from a maximum of 266 mg/kg to a minimum 0.013 mg/kg. The average concentration over the site was 27.8 mg/kg with a standard deviation of 49.6 mg/kg. A large majority of samples measured were above both the NOAA Probable Effects Level for fresh water bulk sediment (>90%) as well as the USEPA Region 3 Freshwater Sediment Screening Benchmarks (>95%) (Buchman, 2008 and USEPA, 2006).

Figure 5-11 provides average bulk soil PCB concentrations for the three sampling events on a log scale (dry weight basis). The sample concentrations plotted are averaged by similar treatment types within the treatment area. Error bars denote the standard error between the replicate samples. Individual sample concentrations are provided in Appendix B. It should be noted that treatment effects of the different amendments are not observable from this plot, as treatments do not reduce the bulk sediment concentration of PCBs (Ghosh et al., 2011). This plot demonstrates the wide heterogeneity of bulk soil concentrations over the treatment area observed over a ten month period. Furthermore, a weakly statistically significant increase in total PCBs is observed between pre-treatment and post-treatment soil samples (population of all treatments pooled). This suggests the potential introduction of a sampling / analysis artifact (e.g. slightly greater sampling recovery depth with each sampling event) or some other unaccounted for variable. Although the difference between pre-treatment and post-treatment is not statistically significant within each plot type, this artifact of increasing trends suggests that temporal trends of pore water and tissue concentrations may equally be affected by the increasing concentration artifact. Table 5-14 outlines in greater detail the individual replicate measures, mean and standard deviation.

Figure 5-11 Bulk Hydric Soil PCB Concentrations

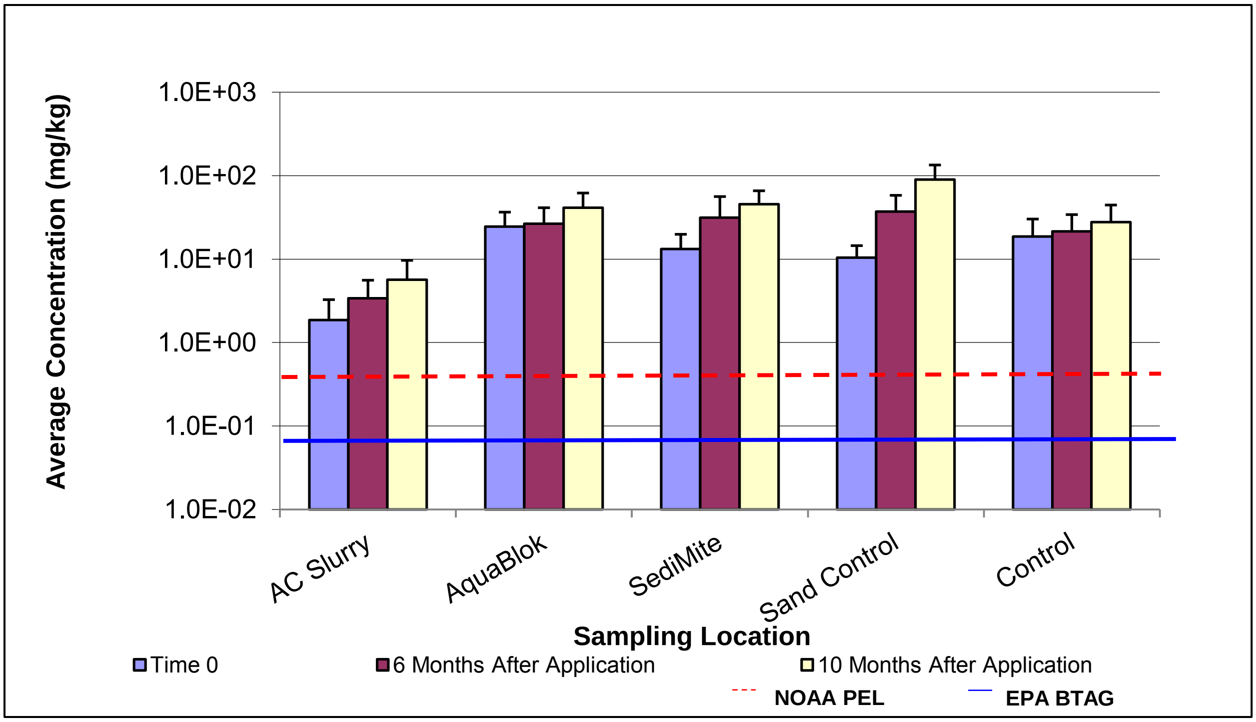


Table 5-14 Bulk Hydric Soil Total PCB Concentrations

Treatment	Sample	Time 0 (mg/kg)	Time 1 (mg/kg)	Time 2 (mg/kg)
Slurry Spray	APG-02	8.70E+00	1.17E+01	2.48E+01
	APG-08	4.08E-01	1.51E+00	6.42E+00
	APG-02/08	1.94E+00	3.48E+00	1.84E+00
	APG-22	1.72E-02	*Not Reported*	2.07E-01
	APG-23	1.69E-02	2.70E-01	5.10E-01
	APG-22/23	5.29E-02	1.25E-02	2.95E-01
	Mean	**1.86E+00**	**3.39E+00**	**5.68E+00**
	Std. Dev	**3.43E+00**	**4.84E+00**	**9.66E+00**
AquaBlok®	APG-05	1.57E+00	6.29E+00	9.42E+00
	APG-09	1.65E+01	*Not Reported*	3.47E+01
	APG-05/09	9.09E+00	1.50E+01	3.35E+01
	APG-11	1.58E-01	6.93E-01	5.63E-01
	APG-13	1.79E+01	1.36E+01	1.32E+02
	APG-11/13	*Not Sampled*	1.39E+01	1.23E+01
	APG-06	1.05E+02	1.51E+02	9.64E-01
	APG-24	3.03E-02	*Not Reported*	8.50E-01
	APG-06/24	8.21E+01	5.39E+01	2.32E+02
	APG-20	1.35E+01	1.04E+01	3.14E+01
	APG-21	6.31E-01	4.53E-01	2.47E+00
	APG-20/21	*Not Sampled*	2.67E-01	8.71E+00
	Mean	**2.47E+01**	**2.66E+01**	**4.16E+01**
	Std. Dev	**4.64E+01**	**7.02E+01**	**1.31E+01**
SediMite™	APG-16	4.88E+00	7.35E+00	Not Reported
	APG-17	4.56E+00	5.93E+00	1.12E+01
	APG-16/17	*Not Sampled*	5.58E+00	1.52E+01
	APG-18	1.09E+01	8.54E+00	2.63E+01
	APG-19	3.24E+01	1.54E+02	1.19E+02
	APG-18/19	*Not Sampled*	7.28E+00	5.63E+01
	Mean	**1.32E+01**	**3.15E+01**	**4.56E+01**
	Std. Dev	**1.31E+01**	**6.01E+01**	**4.47E+01**
Sand Control	APG-01	7.69E+00	5.14E-01	2.66E+02
	APG-03	2.91E+01	7.82E+01	1.71E+02
	Apg-01/03	1.09E+01	1.22E+02	7.92E+01
	APG-10	2.72E-01	8.16E-02	3.35E+00
	APG-14	7.66E+00	1.50E+01	1.42E+01
	Apg-10/14	7.10E+00	6.65E+00	5.34E+00
	Mean	**1.05E+01**	**3.71E+01**	**8.99E+01**
	Std. Dev	**9.78E+00**	**5.10E+01**	**1.08E+02**
Control	APG-04	4.23E+00	1.45E+01	2.48E+01
	APG-07	5.90E+01	8.21E+01	*Not Reported*
	Apg-04/07	2.89E+01	2.16E+01	9.21E+01
	APG-12	1.81E-01	1.76E+00	4.77E+00
	APG-15	1.25E+00	4.33E+00	1.40E+01
	Apg-12/15	*Not Sampled*	5.00E+00	3.24E+00
	Mean	**1.87E+01**	**2.16E+01**	**2.78E+01**
	Std. Dev	**2.54E+01**	**3.06E+01**	**3.70E+01**

Pore Water PCB Concentrations

Pore water PCB concentrations were determined from the same composite hydric soil samples collected from the treatment area in the bulk sediment evaluation. Pore water sampling was conducted with POM passive samplers as described previously in Section 5.7. Pore water concentrations within the testing area were also found to be highly variable. Concentrations prior to the application of reactive treatments ranged over 5 orders of magnitude (maximum $3.73x10^{-02}$ mg/L; minimum $5.69x10^{-07}$ mg/L) with an average concentration of $2.25x10^{-03}$ mg/L and a large standard deviation ($7.07x10^{-03}$). The majority of samples were determined to be above the Maryland ambient water quality standard for Human Health and Consumption (>75%) and a large majority were above the Maryland fresh water chronic ambient water quality standard (>95%) (MDE, 2012).

Following the application of the reactive amendment products, reductions in pore water concentrations were observed for greater than 80% of the plots containing treatments (not controls) during at least one post treatment sampling event (Figure 5-12). Sixty-seven percent of the PCB concentrations in pore water samples from treatment plots above the Aquatic Life Chronic WQS (at Time 0) were reduced to concentrations below this threshold after the reactive treatments were applied (Time 1 and/or Time 2). Pore water concentrations were not reduced to levels below the Maryland Human Health and Consumption WQS, with the exception of one sample.

Figure 5-12 presents the total pore water PCB concentrations for the three sampling events on a log scale. Table 5-15 presents the individual replicate measures, mean and standard deviation between the treatment types. The sample concentrations are organized in the same manner as the bulk hydric soil concentrations were previously presented. The sample concentrations plotted are averaged by all similar treatment types within the treatment area. Error bars denote the standard error between the replicate samples. Individual sample concentrations are provided in Appendix B. The average pore water concentrations by treatment type per event are shown and compared to published water quality standards.

A general decrease in average total PCB pore water concentration was observed within the Slurry Spray and AquaBlok® treatment plots; however, the several orders of magnitude range of concentrations at Time 0 confounds the interpretation of treatment effectiveness based on pore water concentrations alone. Pore water PCB concentrations were relatively unchanged on average in the SediMite™ plots. Differences in pore water PCB concentrations in the SediMite™ plots could be due to the shallower sampling depths achieved in ESTCP project No. ER-200835. Analyses of the SediMite™ plot results will be presented in Dr. Menzie's final report (ER-200835). Mixed results were observed for the average PCB pore water concentrations in the Control and Sand control plots. The period of equilibration for the different treatment types may be different, which may explain the variability of concentration changes within and among treatments. A statistical evaluation is presented in Section 6 and Appendix D.

Figure 5-12 Pore Water Total PCB Concentrations

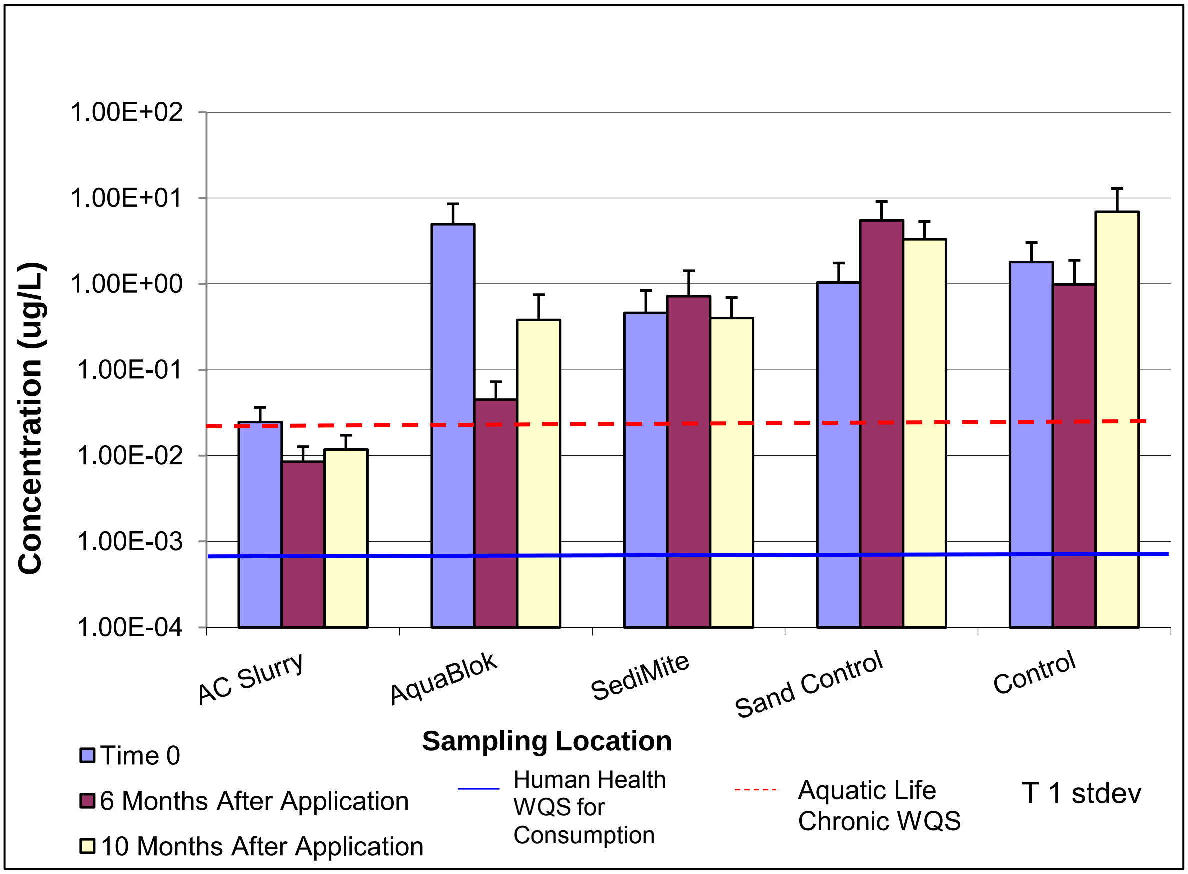


Table 5-15 Pore Water Total PCBs

Treatment	Sample	Time 0	Time 1	Time 2
		Dec-10	Jun-11	Oct-11
		(mg/L)		
Slurry Spray[1]	APG-02	7.11E-05	2.71E-05	3.25E-05
	APG-08	3.30E-05	8.14E-06	2.45E-05
	APG-02/08	3.90E-05	1.15E-05	4.49E-06
	APG-22	5.96E-07	1.62E-06	4.18E-06
	APG-23	7.17E-07	2.87E-07	3.33E-06
	APG-22/23	3.49E-06	2.58E-06	1.53E-06
	Mean	**2.47E-05**	**8.54E-06**	**1.18E-05**
	Std. Dev	**2.84E-05**	**1.00E-05**	**1.33E-05**

Table 5-15 Pore Water Total PCBs (con't)

Treatment	Sample	Time 0	Time 1	Time 2
		Dec-10	**Jun-11**	**Oct-11**
			(mg/L)	
AquaBlok®[1,2]	APG-05	4.70E-05	2.07E-06	8.74E-06
	APG-09	4.35E-04	7.38E-05	9.37E-06
	APG-05/09	3.40E-04	2.87E-06	5.59E-06
	APG-11	7.19E-07	1.46E-06	2.07E-05
	APG-13	2.81E-04	6.10E-06	9.14E-05
	APG-11/13	6.47E-05	6.91E-06	3.17E-06
	APG-06	3.73E-02	3.24E-04	7.22E-06
	APG-24	1.23E-06	2.23E-06	5.10E-06
	APG-06/24	1.58E-02	1.05E-04	4.35E-03
	APG-20	3.88E-04	1.09E-05	5.39E-05
	APG-21	8.72E-06	1.72E-06	1.25E-05
	APG-20/21	*Not Sampled*	1.87E-06	1.51E-05
	Mean	**4.97E-03**	**4.49E-05**	**3.82E-04**
	Std. Dev	**1.17E-02**	**9.41E-05**	**1.25E-03**
SediMite™	APG-16	7.69E-05	3.37E-05	1.95E-05
	APG-17	3.35E-05	1.65E-05	6.54E-05
	APG-16/17	*Not Sampled*	2.53E-05	4.65E-05
	APG-18	1.59E-04	3.38E-05	2.11E-04
	APG-19	1.57E-03	4.19E-03	1.84E-03
	APG-18/19	*Not Sampled*	1.17E-05	2.14E-04
	Mean	**4.60E-04**	**7.19E-04**	**3.99E-04**
	Std. Dev	**7.42E-04**	**1.70E-03**	**7.11E-04**
Sand Control	APG-01	5.95E-06	6.73E-06	1.76E-03
	APG-03	4.29E-03	2.07E-02	1.19E-02
	APG-01/03	1.67E-03	1.18E-02	6.11E-03
	APG-10	2.43E-06	9.30E-06	7.26E-06
	APG-14	1.72E-04	2.15E-04	1.09E-04
	APG-10/14	8.37E-05	1.30E-04	4.25E-05
	Mean	**1.04E-03**	**5.48E-03**	**3.32E-03**
	Std. Dev	**1.72E-03**	**8.81E-03**	**4.81E-03**

Table 5-15 Pore Water Total PCBs (con't)

Treatment	Sample	Time 0	Time 1	Time 2
		Dec-10	Jun-11	Oct-11
		(mg/L)		
Control	APG-04	1.67E-04	1.56E-04	2.46E-04
	APG-07	6.19E-03	5.41E-03	3.62E-02
	APG-04/07	2.62E-03	2.20E-04	4.87E-03
	APG-12	3.99E-06	9.63E-06	2.48E-05
	APG-15	3.87E-05	7.43E-05	1.00E-04
	APG-12/15	*Not Sampled*	3.52E-05	1.27E-05
	Mean	**1.80E-03**	**9.84E-04**	**6.91E-03**
	Std. Dev	**2.69E-03**	**2.17E-03**	**1.45E-02**

[1] Post-treatment concentrations are statistically significantly lower than the Control (see Section 6 and Appendix D)
[2] Post-treatment concentrations are statistically significantly lower than pre-treatment (see Section 6 and Appendix D)

Pore water concentrations were also measured *in situ* with polyethylene device (PED) passive samplers to evaluate the PCB concentration profile with depth within 20 of the treatment plots. (Figure 5-13). *In situ* measurements of SediMite™ plots were not sampled because the passive samplers were deployed prior to the decision to include this treatment method. Pore water concentrations are presented by treatment plot and grouped by similar treatment on a log-scale (Time 2). The highest pore water concentrations were observed in the Sand control and Control plots. On average, pore water concentrations increased with depth. Results were mixed for the treatment plots amended with activated carbon. Pore water concentrations within the top two inches of the Slurry Spray and AquaBlok® treatment plots were lower than concentrations observed within the bottom 4 inches for half of the samples recovered.

Soil cores show AC distribution into void spaces in the top 2 to 3 inches of the sediment core shortly after placement. Additional analysis needs to be conducted to determine the extent of mixing into the underlying sediments, the mechanisms of mixing, and the timeframe over which it occurs. Mixing should be evaluated either visually or chemically with the collected cores from Time 1 and Time 2, due to the large vertical and spatial heterogeneity observed. Table 5-16 presents the results, calculated mean, and standard deviation for each treatment.

Figure 5-13 ***In Situ* Pore Water PCB Concentration Comparison**

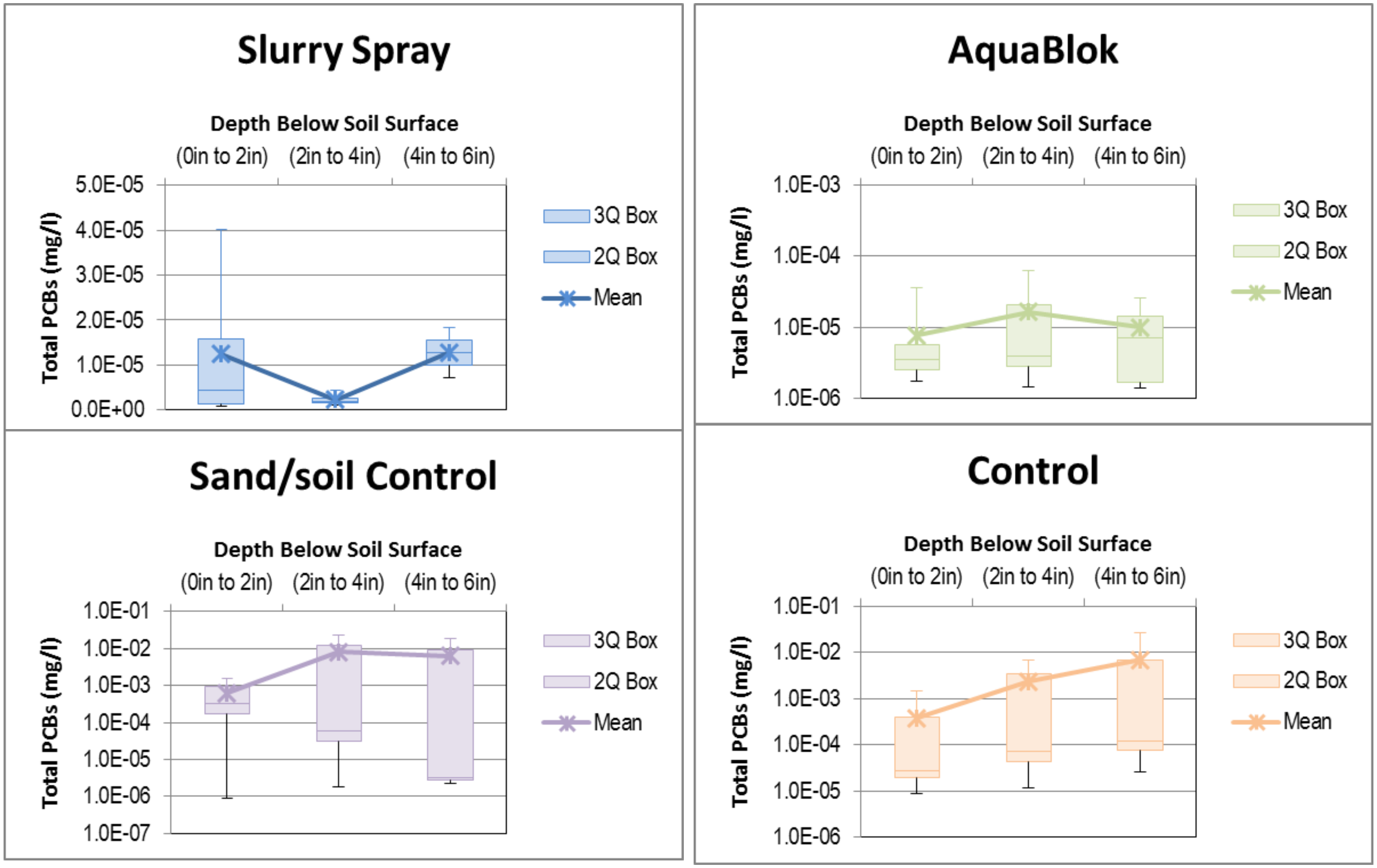


Table 5-16 *In Situ* Pore Water Total PCBs

Treatment	Sample	Top (0in to 2in)	Middle (2in to 4in)	Bottom (4in to 6in)
		(mg/L)		
Slurry Spray	APG-02	9.29E-07	1.07E-06	1.84E-05
	APG-08	7.54E-06	4.31E-06	7.32E-06
	APG-22	1.40E-06	1.89E-06	*Not Reported*
	APG-23	4.02E-05	1.95E-06	*Not Reported*
	Mean	**1.25E-05**	**2.31E-06**	**1.29E-05**
	Std. Dev	**1.87E-05**	**1.40E-06**	**7.83E-06**
AquaBlok®	APG-05	3.06E-06	3.90E-06	2.58E-05
	APG-09	5.32E-06	9.30E-06	*Not Reported*
	APG-11	3.65E-05	3.23E-05	1.43E-05
	APG-13	2.57E-06	2.48E-06	*Not Reported*
	APG-06	4.05E-06	6.31E-05	*Not Reported*
	APG-24	1.74E-06	*Not Reported*	1.68E-06
	APG-20	6.47E-06	1.44E-06	1.39E-06
	APG-21	2.24E-06	3.07E-06	6.99E-06
	Mean	**7.74E-06**	**1.65E-05**	**1.00E-05**
	Std. Dev	**1.17E-05**	**2.32E-05**	**1.03E-05**
Sand Control	APG-01	8.90E-07	1.81E-06	3.18E-06
	APG-03	1.52E-03	2.37E-02	1.87E-02
	APG-10	*Not Reported*	*Not Reported*	2.27E-06
	APG-14	3.34E-04	6.00E-05	*Not Reported*
	Mean	**6.18E-04**	**7.92E-03**	**6.24E-03**
	Std. Dev	**7.98E-04**	**1.37E-02**	**1.08E-02**
Control	APG-04	3.16E-05	*Not Reported*	9.22E-05
	APG-07	1.46E-03	6.89E-03	2.70E-02
	APG-12	8.65E-06	1.16E-05	2.65E-05
	APG-15	2.30E-05	7.25E-05	1.43E-04
	Mean	**3.81E-04**	**2.32E-03**	**6.82E-03**
	Std. Dev	**7.20E-04**	**3.95E-03**	**1.35E-02**

Although comparisons between the concentration profiles among the *in situ* samples can be made with confidence, direct comparisons between *in situ* measured concentrations and laboratory evaluations should be made with caution. Laboratory pore water measurements on grab samples reach equilibrium, and the methodology is well established. However, equilibrium is assumed for

in situ pore water measurements. Equilibrium for *in situ* passive samples is generally established via performance reference standards. Performance reference standards were not conducted at this location; however, samplers were deployed for a 10 month period such that equilibrium was likely attained.

***Lumbriculus* Tissue PCB Results**

Bioaccumulation studies were conducted on composite hydric soil samples collected during the same three sampling events as the bulk hydric soil and pore water evaluations. Sediment sampling procedures, benthic sampling procedures and analytical procedures are described in Section 5.7.

Tissue concentrations from benthic organisms (*L. variegatus*) exposed to sediments within the testing area were found to be highly variable. Concentrations prior to the application of reactive treatments ranged over 4 orders of magnitude (maximum $3.57\text{x}10^{+02}$ mg/kg; minimum $4.33\text{x}10^{-02}$ mg/kg) with an average concentration of 2.25 mg/kg and a large standard deviation ($1.21\text{x}10^{+02}$). Following the application of the reactive amendment products, reductions in tissue concentration were observed for all of the treatments in which Time 0 data was available (Slurry Spray and AquaBlok®). Time 0 concentrations for the SediMite™ treatment plots were not available. Tissue concentrations were observed to fluctuate in the Sand control and untreated Control plots in the post-treatment sampling events. Benthic tissue PCB concentrations are provided in Figure 5-14.

The AquaBlok® *Lumbriculus* receptor tissue concentrations were statistically significantly different between pre- and post-treatment (but were lower post-treatment, in this case). Slurry Spray and Sand control *Lumbriculus* receptor tissue concentrations were not statistically significant different when post-treatment data were compared to pre-treatment concentrations. However, AquaBlok® and Slurry Spray post-treatment *Lumbriculus* receptor tissue concentrations were statistically significantly lower than the post-treatment Control. As discussed previously with the pore water results, evaluating the tissue concentrations of exposed invertebrate is a good metric to evaluate the environmental risk of PCBs within the treatment area but not necessarily a good indicator of treatment performance due to heterogeneity across the bulk phase.

Figure 5-14 *Lumbriculus* Tissue Total PCB Concentrations

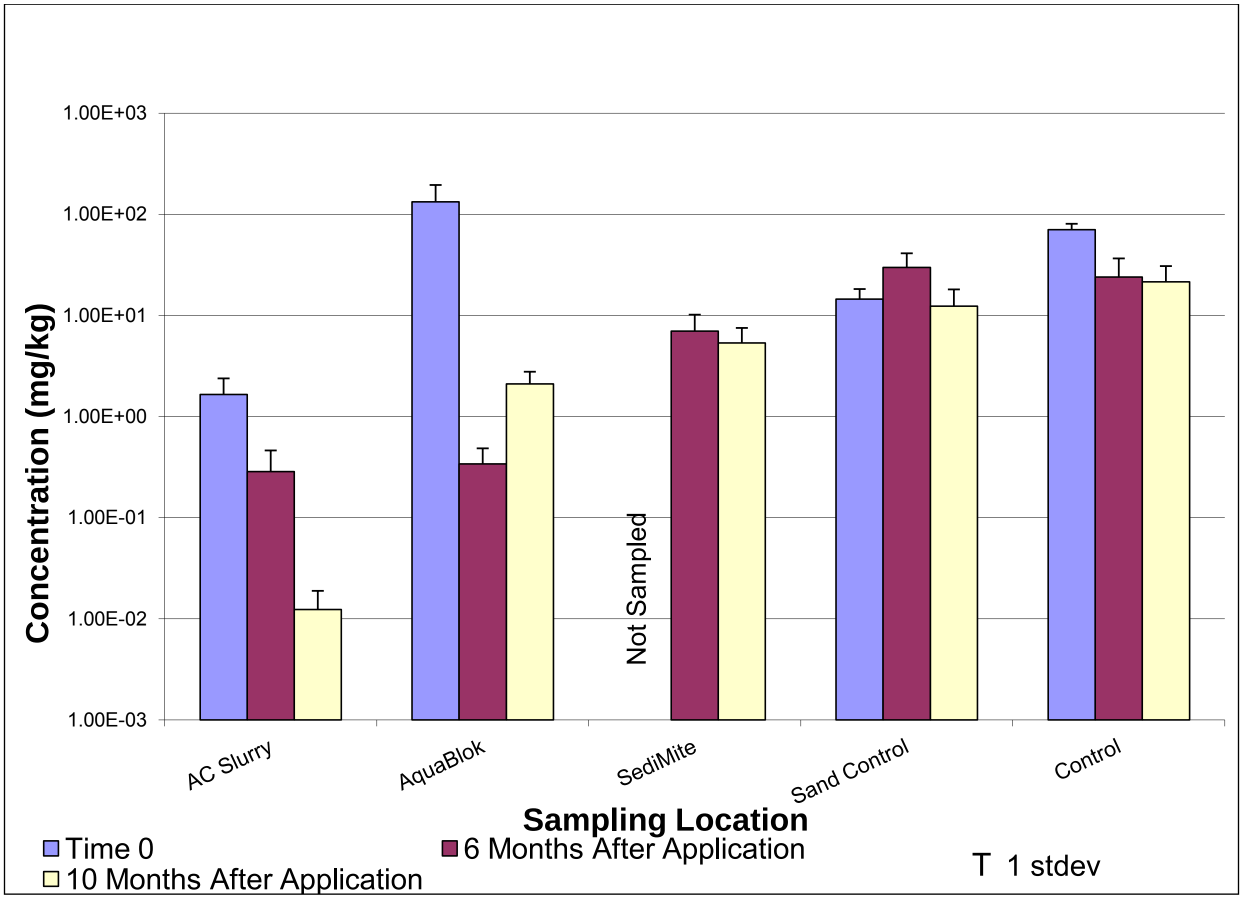


Table 5-17 presents the individual replicate measurements, mean, and standard deviation of the data.

Table 5-17 *Lumbriculus* Tissue Total PCBs Results

Treatment	Sample	Time 0	Time 1	Time 2
		(mg/kg)		
Slurry Spray[1]	APG-02/08a	3.10E+00	7.47E-01	3.99E-02
	APG-02/08b	3.66E+00	3.72E-01	1.89E-02
	APG-02/08c	3.01E+00	*Not Sampled*	1.51E-02
	APG-22/23a	2.43E-02	1.95E-02	0.00E+00
	APG-22/23b	4.10E-02	0.00E+00	0.00E+00
	APG-22/23c	6.45E-02	*Not Sampled*	0.00E+00
	Mean	**1.65E+00**	**2.85E-01**	**1.23E-02**
	Std. Dev	**1.77E+00**	**3.52E-01**	**1.59E-02**

Table 5-17 *Lumbriculus* Tissue Total PCBs Results (con't)

Treatment	Sample	Time 0	Time 1	Time 2
		(mg/kg)		
AquaBlok®[1,2]	APG-05/09a	2.11E+01	7.59E-01	1.72E-02
	APG-05/09b	2.71E+01	1.13E-01	3.37E-02
	APG-05/09c	2.80E+01	*Not Sampled*	3.61E-02
	APG-11/13a	1.42E+01	2.76E-02	3.77E-01
	APG-11/13b	1.42E+01	3.56E-02	3.33E+00
	APG-11/13c	1.46E+01	*Not Sampled*	7.85E-01
	APG-06/24a	2.37E+02	4.52E-01	4.99E+00
	APG-06/24b	5.32E+02	1.12E+00	6.64E+00
	APG-06/24c	3.02E+02	*Not Sampled*	5.14E+00
	APG-20/21a	*Not Sampled*	1.77E-01	1.42E+00
	APG-20/21b	*Not Sampled*	2.15E-02	1.28E+00
	APG-20/21c	*Not Sampled*	*Not Sampled*	1.08E+00
	Mean	**1.32E+02**	**3.38E-01**	**2.09E+00**
	Std. Dev	**1.86E+02**	**4.08E-01**	**2.32E+00**
SediMite™	APG-16/17a	*Not Sampled*	1.41E+00	6.26E-01
	APG-16/17b	*Not Sampled*	4.19E+00	7.29E-01
	APG-16/17c	*Not Sampled*	*Not Sampled*	5.25E-01
	APG-18/19a	*Not Sampled*	6.43E+00	8.04E+00
	APG-18/19b	*Not Sampled*	1.59E+01	1.16E+01
	APG-18/19c	*Not Sampled*	*Not Sampled*	1.05E+01
	Mean	**Not Sampled**	**6.98E+00**	**5.34E+00**
	Std. Dev	**Not Sampled**	**6.29E+00**	**5.29E+00**
Sand Control	APG-01/03a	1.73E+01	2.66E+01	3.19E+01
	APG-01/03b	2.27E+01	5.06E+01	2.23E+01
	APG-01/03c	2.43E+01	*Not Sampled*	1.91E+01
	APG-10/14a	1.00E+01	1.21E+01	3.08E-01
	APG-10/14b	0.00E+00	*Not Sampled*	3.41E-01
	APG-10/14c	1.27E+01	*Not Sampled*	1.11E-01
	Mean	**1.45E+01**	**2.98E+01**	**1.23E+01**
	Std. Dev	**9.00E+00**	**1.94E+01**	**1.39E+01**

Table 5-17 *Lumbriculus* Tissue Total PCBs Results (con't)

Treatment	Sample	Time 0	Time 1	Time 2
		(mg/kg)		
Control	APG-04/07a	8.53E+01	5.03E+01	4.12E+01
	APG-04/07b	7.42E+01	4.06E+01	4.09E+01
	APG-04/07c	5.23E+01	*Not Sampled*	4.35E+01
	APG-12/15a	*Not Sampled*	3.09E+00	1.41E+00
	APG-12/15b	*Not Sampled*	1.83E+00	9.96E-01
	APG-12/15c	*Not Sampled*	*Not Sampled*	1.11E+00
	Mean	**7.06E+01**	**2.40E+01**	**2.15E+01**
	Std. Dev	**1.68E+01**	**2.51E+01**	**2.23E+01**

[1] Post-treatment concentrations are statistically significantly lower than the Control (see Section 6 and Appendix D)

[2] Post-treatment concentrations are statistically significantly lower than pre-treatment (see Section 6 and Appendix D)

5.8.4 Ecological Assessment

Ecological response to treatment was assessed by vegetation survey metrics, plant nutrient uptake, and benthic community survey metrics.

Vegetation Survey

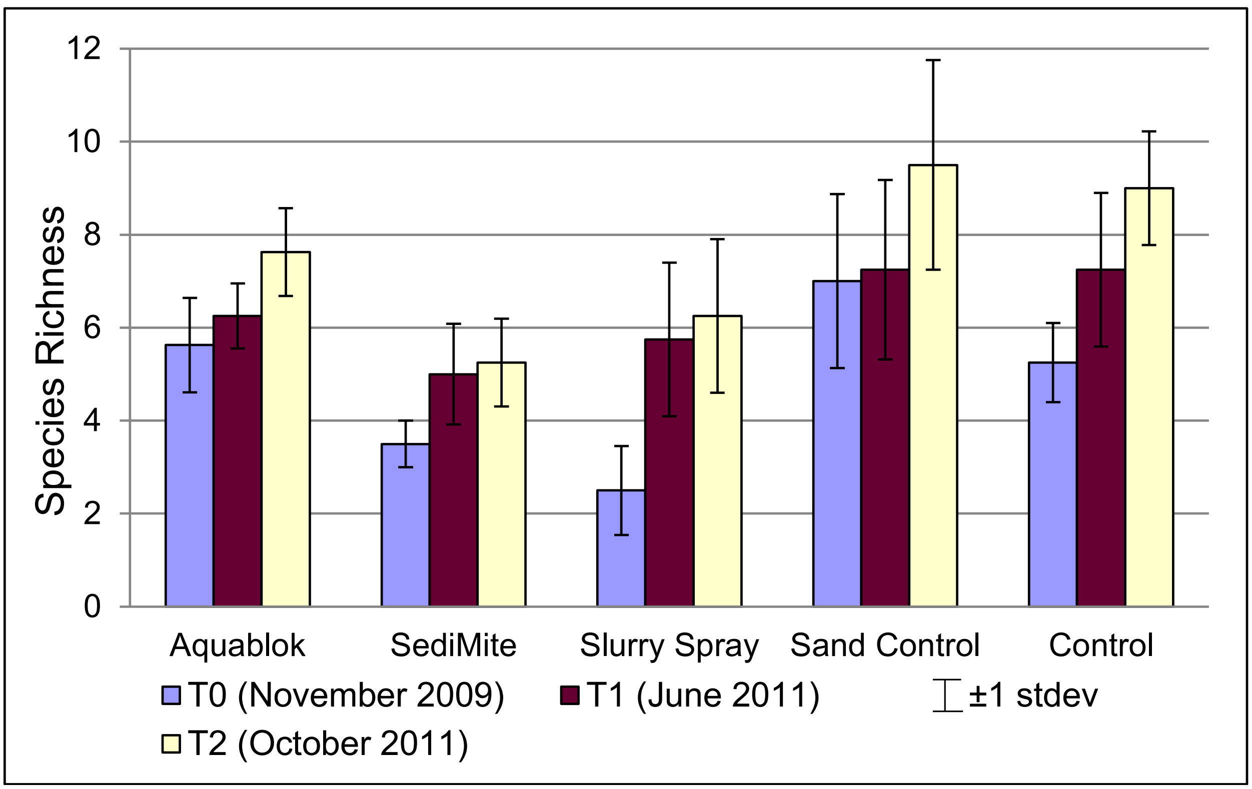
The Field Demonstration wetland is approximately 2 acres in size and borders approximately 680 linear feet (lft) of Canal Creek. The Time 0 survey was conducted 13 months prior to the treatment application (November 2009). Appendix E includes a comprehensive survey of the vegetation community, which is briefly summarized here. Approximately 32% (0.64 acres) of the total demonstration area consists of a dense mono-culture stand of common reed (*Phragmites australis*), an invasive plant species in Maryland. Another 33% (0.65 acres) of the demonstration area is dominated by narrow-leaved cattail (*Typha angustifolia*), which is not considered "invasive", however it is often considered an aggressive colonizer and tends to form dense mono-culture stands. The remaining portions of the field demonstration area were characterized as shallow emergent marsh (19%; 0.38 acres) and deep emergent marsh (16%; 0.34 acres). A total of 49 plant species were observed within the field demonstration wetland, the majority of which were herbaceous perennials, sedges, rushes and aquatic emergent plants (n=32). Shrubs (6), grasses (4), vines (4), trees (2) and 1 sub-aquatic vascular plant were identified. Surveys of the 24 plots were conducted at Time 0, Time 1, and Time 2.

Common reed persists as a dense mono-culture stand (>90% cover) in only four of the plots. One plot had >60% but < 90% cover. Common reed was observed in lower densities (3-20% cover) in nine plots. Narrow-leaved cattails were present in seven plots with >60% cover, and 10 plots with

3-20% cover. One other invasive species observed within the field demonstration wetland was bladderwort (*Utricularia sp.*). This plant was observed in only two plots and within the river itself.

Species richness ranged from one to a maximum of 19 species within a treatment plot. Species richness in plots dominated by common reed tended to be low ranging from only 1 to 5 (mean = 4.5) species. As expected, species richness was higher in plots dominated by shallow marsh or with a mixture of shallow and deep marsh habitats (6-13 species, mean = 9.0). Deep marsh habitats dominated by Arrow arum (*Peltandra virginica*) had only 4 to 5 (mean 4.7) species present. The narrow-leaved cattail dominated plots tended to exhibit the highest species richness ranging from 10 to 19 (mean = 12.9) species. No statistically significant variation was found between plots containing treatments and control plots in the post application sampling events. A statistically significant variation in species richness was observed across all plots between sampling events so any change over time due to treatment effect was not observable (F = 8.351, p = 0.001, d.f. = 2), perhaps because assessments were not conducted at the same time of the year. Figure 5-15 presents the average species richness and standard error for each treatment type over the three sampling periods.

Figure 5-15 Species Richness Results



Within each sampling event, vegetation cover tended to be high in each plot with overlapping vegetation layers often resulting in percent cover ranging to well over 100% (Figure 5-16). At Time 0, Time 1 and Time 2, only nine, two, and six plots had <90% cover, respectively. There was no difference in relative cover between sampling events (F = 0.537, p = 0.466, d.f. = 2). Diversity at Time 0 was not different from Time 1 or Time 2 (F = 0.713, p = 0.494, d.f. = 2) (Figure 5-17).

Figure 5-16 Relative Cover Results

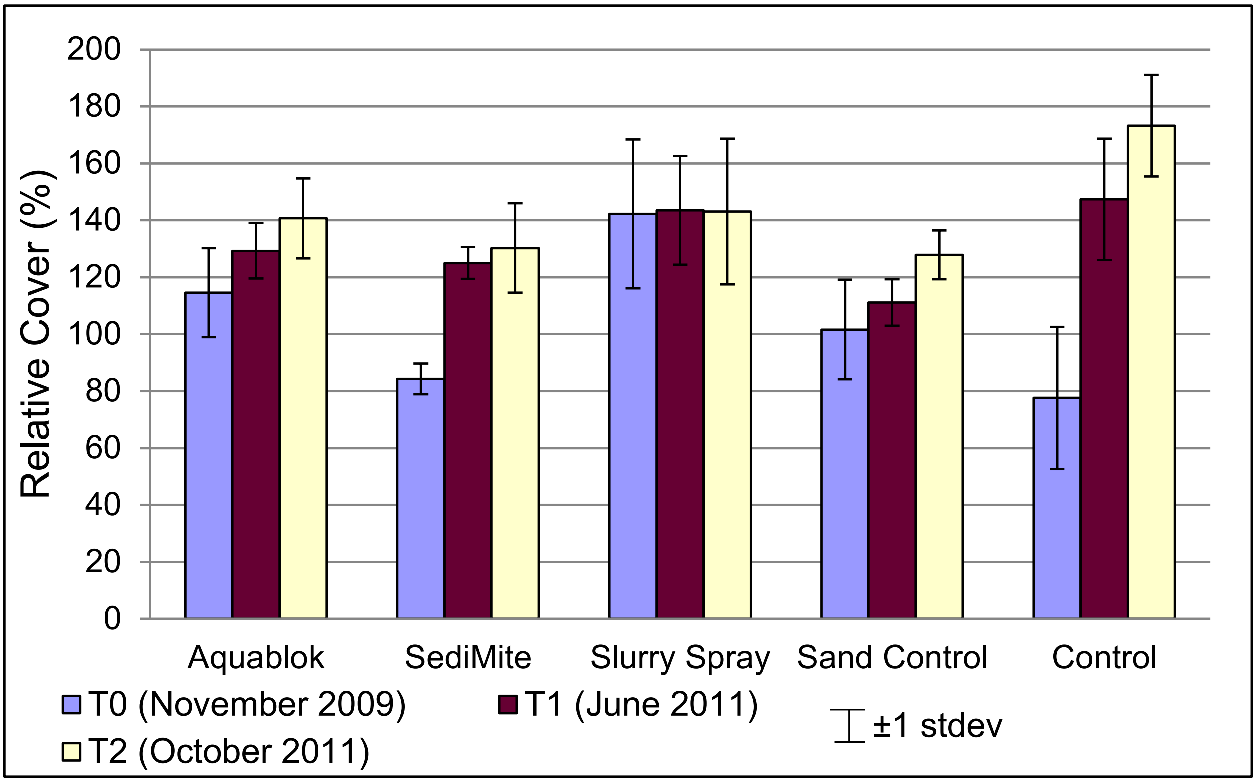
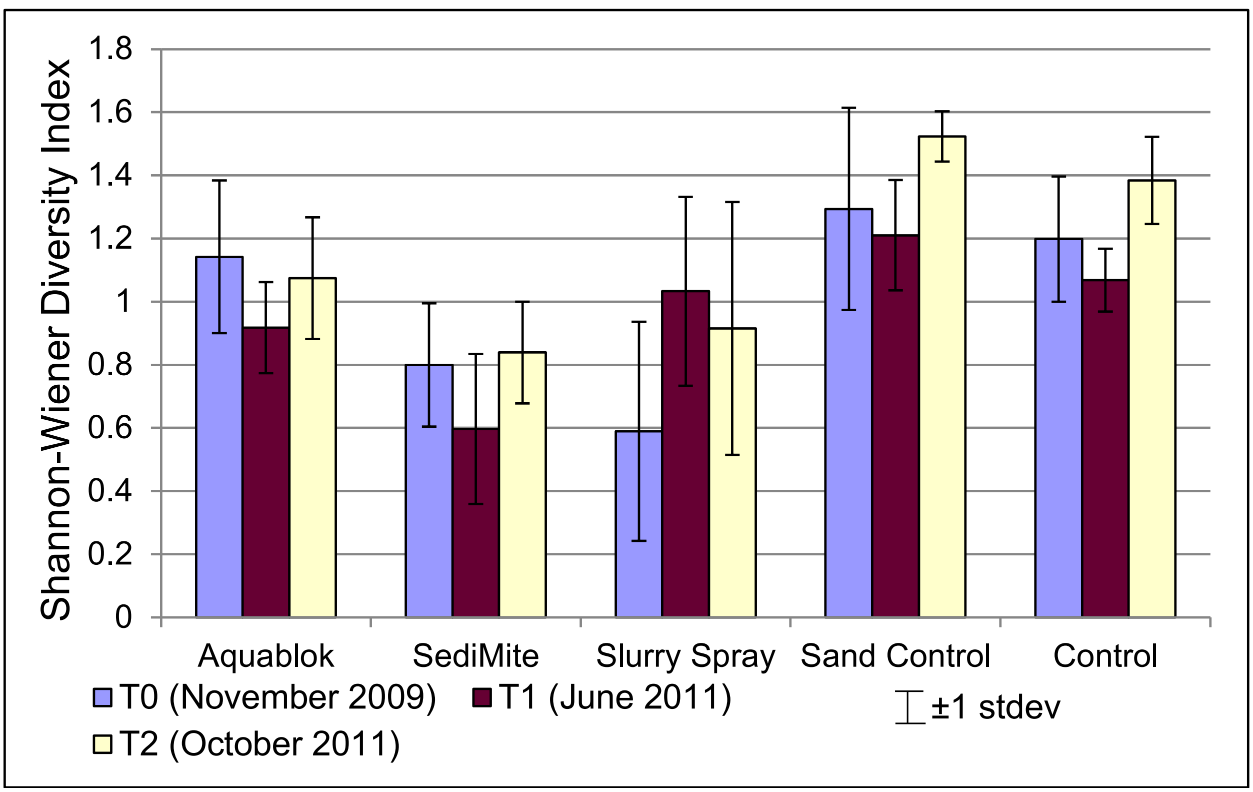


Figure 5-17 Shannon-Weiner Diversity Index

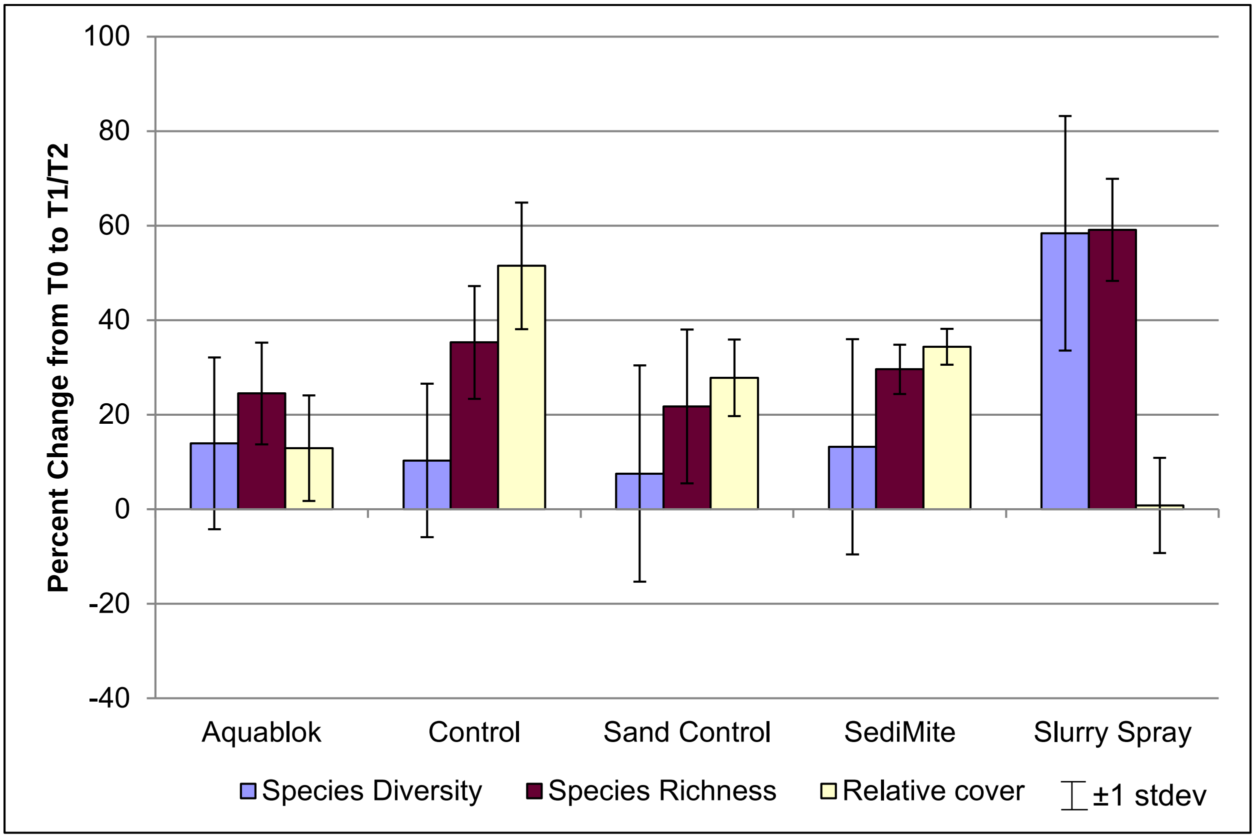


Vegetation characteristics within each of the 24 survey plots were statistically significantly correlated between pre- and post-treatment periods. Correlations for species richness were particularly high for Time 0 versus Time 1 (r = 0.69; $p < 0.05$) and Time 0 versus Time 2 (r = 0.81; $p < 0.05$). Similarly, Time 1 versus Time 2 were also highly correlated (r = 0.90; $p < 0.05$). Relative cover and Diversity were not statistically significantly correlated for Time 0 versus Time 1, but they were for Time 0 versus Time 2 (Cover: $r_s = 0.67$; $p < 0.05$; Diversity: r = 0.51; $p < 0.05$).

No differences among treatments were observed post-application for relative cover (F = 0.646, $p = 0.633$, d.f. = 4), or species richness (F = 2.063, $p = 0.102$, d.f. = 4). Species diversity among treatments was marginally statistically significant (F = 2.515, $p = 0.055$, d.f. = 4), and some differences between treatments and controls were also observed. The SediMite™ treatment plots (mean = 0.718 ± 0.16) exhibited statistically significantly lower diversity when compared to the Control (mean = 1.23 ± 0.16, t = 2.017, $p = 0.029$) and the Sand control (mean = 1.37 ± 0.16, t = 2.017, $p = 0.006$).

Changes in diversity, richness and relative cover between pre- and post-treatment time periods were observed that were greater than the 25% of plant community metric condition used by the USEPA. However, with the exception of 5 plots (APG-20 and APG-9 treated with AquaBlok®, APG-10 in the Sand control, APG-18 treated with SediMite™, and APG-2 treated with the Slurry Spray; see Appendix E), these changes were generally in a positive direction on a plot-by-plot basis, and on average within treatments were in a positive direction (see Figure 5-18). As described above, these variations are likely attributable to high spatial and temporal variability observed within these data. The scattered nature of these reductions in species diversity or relative cover does not indicate a clear trend of adverse impacts due to the application of the treatments themselves.

Figure 5-18 Percent Change in Measured Plant Metrics from Pre-treatment to Post-treatment



Plant Nutrient Study Results

Laboratory testing was conducted by the AECOM Fort Collins Environmental Toxicology Laboratory in Fort Collins, Colorado in order to assess the potential for adverse impacts of the treatments on plant health and the ability of plants to uptake nutrients. Japanese millet (*E. crusgalli*) seedlings were exposed to soil samples collected from three treatment plots (APG-02 Slurry Spray, APG-06 AquaBlok®, APG-16 SediMite™), an un-treated Control plot (APG-15 Site Control), and a laboratory control soil for a test duration of 77 days.

Survival at test termination ranged from 97.5% in the laboratory control to 100% in APG-02, APG-06, and APG-16 indicating that the treatments showed no adverse effects on plant survival. Similarly, no statistically significant adverse sub-lethal affects were observed for the plant growth endpoints (plant shoot wet weight, plant shoot dry weight, or plant shoot length) relative to the laboratory control or APG-15 (Site Control) results. All three growth metrics in the APG-16 (SediMite™) sample were statistically higher than in the APG-15 (Site Control) sample.

The following metals and nutrients were measured in the soils and the plant tissue: boron, calcium, copper, iron, magnesium, manganese, phosphorus, potassium, sodium, sulfur, zinc, nitrogen. The uptake measured as the ratio of nutrient concentration in plant to concentration in soil was typically not statistically significantly different from Site Control ("—") to increased nutrient uptake on average (↑ or ↓), as shown in Figure 5-19.

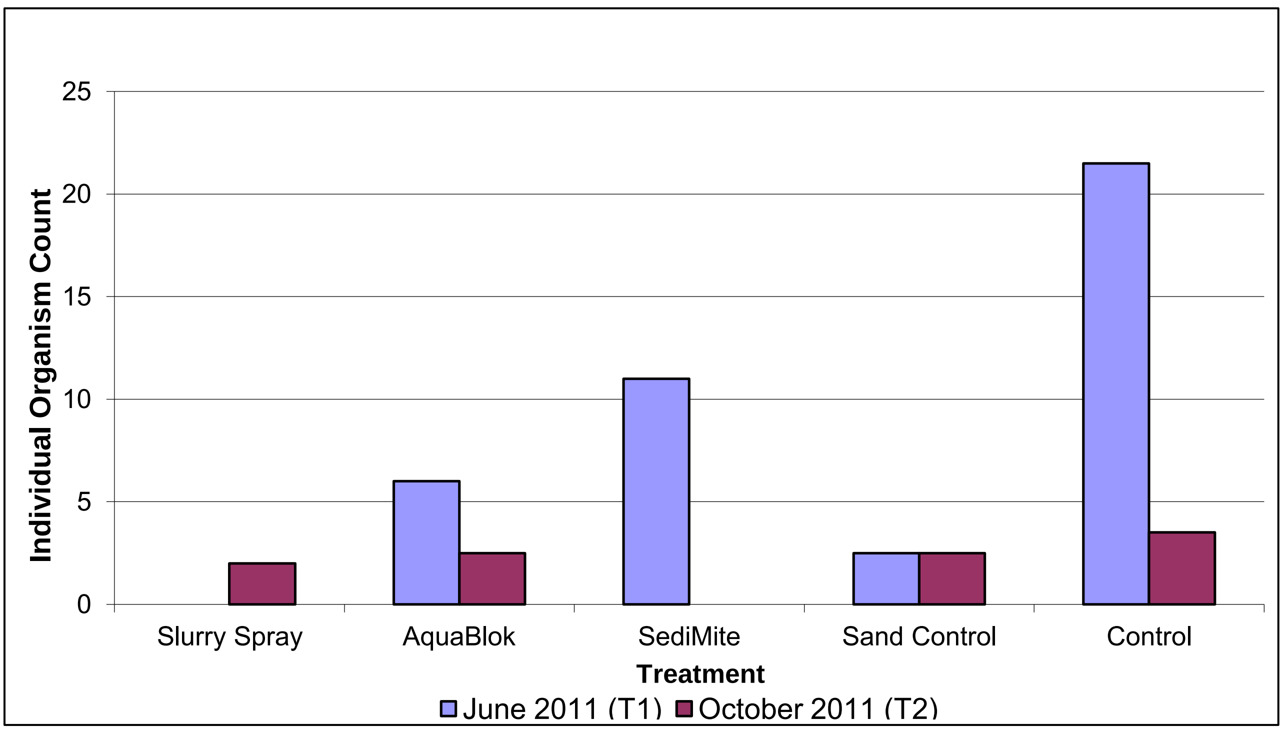
Figure 5-19 Plant Nutrient Uptake

Treatment	B	Ca	Cu	Fe	Mg	Mn	P	K	Na	S	Zn	N
Slurry Spray (APG-02)	↑	↑	↑	---	↑	↑	↑	↑	---	---	↑	↑
AquaBlok® (APG-06)	↑	---	↑	---	↑	---	↑	↑	---	---	↑	↑
SediMite™ (APG-16)	---	↑	---	---	↑	---	---	---	---	↓	---	---

Macroinvertebrate Survey Results
Benthic core samples were analyzed by WAA for macroinvertebrate composition to determine the impacts to the benthic macroinvertebrate community structure due to the application of the treatments. Samples from eight plots within each treatment were collected at Time 1 and Time 2 following the application of the treatments.

The macroinvertebrate populations were small for each sampling event and considerable uncertainty is associated with analysis of these data. A total of 71 organisms representing 13 different taxa were recovered in the Time 1 sampling event and 19 organisms representing 5 different taxa were collected at Time 2. Results are shown in Figure 5-20.

Figure 5-20 Macroinvertebrate Population Count by Treatment Type



At the Time 1 sampling event, Stations APG-07 (Control), APG-13 (AquaBlok®), APG-15 (Control), and APG-16 (SediMite™) were the only stations containing organisms in all three replicate samples within a test plot. Other sampled plots (APG-02, APG-03, APG-06, APG-14)

either lacked organisms or had organisms in only one of the three replicate samples. At the Time 1 sampling event, only stations APG-15 and APG-14 (Sand control) had organisms in more than one replicate sample. The laboratory report is provided in Appendix F.

6.0 PERFORMANCE ASSESSMENT

Data were statistically analyzed to identify significant differences between treatments and controls. Data were evaluated based on the success criteria described in Section 3 to determine if the performance objectives of the demonstration were met.

6.1 REMEDIATION EFFECTIVENESS

Remediation effectiveness was assessed by measuring the reduction in the bioavailability of PCBs as indicated by organic carbon normalization of soil concentrations, changes in pore water concentrations and the reduction in bioaccumulation as indicated by macroinvertebrate tissue concentrations in 28-day bioaccumulation studies. Changes in the partitioning of PCBs from pore water to the bulk solid phase and from macroinvertebrate tissue to the bulk solid phase were also assessed to account for the large heterogeneity in concentrations observed across the treatment site.

6.1.1 Organic Carbon Normalization

As a first order evaluation of the potential reduction in the bioavailability of PCBs, bulk soil concentrations were normalized to organic carbon content, shown on Table 6-1. On average, normalized concentrations are on the order of 8 to 14 percent greater than the measured bulk soil concentration, indicating PCBs are strongly sorbed to organic carbon in this system. An evaluation of bioavailability based on organic carbon normalization alone is likely to underestimate bioavailability due to the addition of black carbon during treatment, which more strongly sorbs HOCs than natural organic carbon.

Table 6-1 Soil Organic Carbon Normalized PCBs

Treatment	Sample	Time 0	Time 1	Time 2
		Dec-10	Jun-11	Oct-11
		(mg/kg oc)		
Slurry Spray	APG-02	4.64E-01	4.90E-01	1.02E+00
	APG-08	4.28E-02	1.20E-01	4.78E-01
	APG-22	1.05E-03	--	7.56E-03
	APG-23	6.52E-04	1.49E-02	2.32E-02
	Mean	**1.27E-01**	**2.08E-01**	**3.81E-01**
	Std. Dev	**2.25E-01**	**2.50E-01**	**4.76E-01**
AquaBlok®	APG-05	1.55E-01	4.46E-01	6.65E-01
	APG-09	1.09E+00	--	2.03E+00
	APG-11	5.08E-03	--	--
	APG-13	7.91E-01	5.46E-01	7.91E+00
	APG-06	1.67E+01	9.75E+00	6.72E-02
	APG-24	--	--	--
	APG-20	6.98E-01	3.89E-01	2.29E+00
	APG-21	--	--	--
	Mean	**3.24E+00**	**2.78E+00**	**2.59E+00**
	Std. Dev	**6.61E+00**	**4.65E+00**	**3.12E+00**

Table 6-1 Soil Organic Carbon Normalized PCBs (con't)

Treatment	Sample	Time 0	Time 1	Time 2
		Dec-10	**Jun-11**	**Oct-11**
		(mg/kg oc)		
SediMite™	APG-16	2.63E-01	3.32E-01	--
	APG-17	2.86E-01	2.95E-01	5.90E-01
	APG-18	5.53E-01	5.15E-01	1.41E+00
	APG-19	1.65E+00	1.22E+01	7.21E+00
	Mean	**6.89E-01**	**3.33E+00**	**3.07E+00**
	Std. Dev	**6.56E-01**	**5.90E+00**	**3.61E+00**
Sand Control	APG-01	3.45E-01	3.64E-02	3.63E+01
	APG-03	4.32E+00	1.20E+01	1.96E+01
	APG-10	1.19E-02	5.93E-03	--
	APG-14	4.07E-01	1.73E+00	6.34E-01
	Mean	**1.27E+00**	**3.43E+00**	**1.88E+01**
	Std. Dev	**2.04E+00**	**5.74E+00**	**1.78E+01**
Control	APG-04	3.14E-01	7.56E-01	1.83E+00
	APG-07	1.21E+01	8.05E+00	--
	APG-12	6.84E-03	8.02E-02	2.86E-01
	APG-15	7.85E-02	3.50E-01	5.78E-01
	Mean	**3.13E+00**	**2.31E+00**	**8.97E-01**
	Std. Dev	**6.00E+00**	**3.84E+00**	**8.19E-01**

6.1.2 Evaluation of Pre- and Post-Treatment Pore Water Concentrations

An ANOVA statistical analysis and Student's T means statistical comparison was conducted on all post-treatment pore water concentration data by treatment type (AquaBlok®, Control, Sand control, SediMite™ and Slurry Spray). ANOVA determined that treatment type was a statistically significant variable for pore water concentration. Student's T means statistical comparison determined that the AquaBlok® and Slurry Spray were statistically separate from the Control. Dunnet's mean statistical comparison (with Control set as the control) confirmed that AquaBlok® and Slurry Spray were both statistically different from the Control.

Table 6-2 summarizes the statistical analyses results between pre- and post-treatment pore water concentrations within each plot. Pore water concentrations, except for AquaBlok®, were not statistically significantly different between pre- and post-treatment. However, AquaBlok® and Slurry Spray post-treatment pore water concentrations were statistically significantly lower than the post-treatment Control.

Table 6-2 ANOVA Analysis of Pre- and Post-Treatment Pore Water Concentrations Within Each Treatment Type

Treatment	F Ratio	Probability (>*p*)	Significant Variance
Slurry Spray	0.1993	0.6612	No
AquaBlok®	6.8005	0.0136	Yes
SediMite™	0.3791	0.5480	No
Sand Control	0.5685	0.4618	No
Control	0.0001	0.9908	No

Although decreasing trends in the pore water direct measurement is likely to be of most interest to regulatory agencies, an additional line-of-evidence was the evaluation using another metric of bioavailability, partitioning. The aforementioned magnitude of variability and spatial heterogeneity in PCBs, small sample sizes, and the noted potential sampling artifact, required this alternative approach.

6.1.3 Reduction in Bioavailability of PCBs

The reduction in bioavailability of PCBs were evaluated through two metrics measured within this study that are demonstrative of bioavailability within the natural system; pore water samples and *L. variegatus*) receptor tissue from 28-day bioaccumulation studies. Following initial comparisons, it was determined that the large spatial heterogeneity in bulk PCB concentrations did not lend to direct comparisons of the data between the treatment plots and multiple sampling events. To normalize the data, the partitioning between hydric soil concentrations and bioavailable demonstrative concentrations (pore water and *L. variegatus*) were calculated (Equations 6-1, 6-2 and 6-3). The pore water to solid bulk phase partitioning coefficient ($K_{bulk/PW}$), referred to as the pore water partitioning coefficient, is the concentration of the bulk phase (in this case hydric soil plus amendment) divided by the pore water concentration. The organic carbon normalized solid bulk phase divided by the pore water concentration can also be calculated, which is a more commonly conducted bioavailability assessment (Di Toro et al., 1991) and is referred to here as the carbon normalized pore water partitioning coefficient. Similarly, *Lumbriculus* to bulk soil partitioning ($K_{Bulk/Lv}$), the *Lumbriculus* partitioning coefficient, is the solid bulk phase concentration divided by the *L. variegatus* tissue concentration. Increase in the partitioning coefficient is a result of lower concentrations within the bioavailable phases while the bulk solid phase concentration remains constant; therefore, increased partitioning values represent a greater treatment effect due to the amendment application. While pore water to soil partitioning describes a direct physical interaction between two phases, *Lumbriculus* partitioning simplifies a complex relationship between living organism and the bulk phase (e.g. digestion, dermal exposure, etc.). Notwithstanding this simplification, the intent of this metric is to derive a value which describes the bioavailable fraction of PCB while normalizing for the large spatial heterogeneity across the treatment site so that effective comparisons might be made between each treatment type (i.e., assess effectiveness using BSAFs).

Equation 6-1 Pore Water Partitioning Coefficient

$$K_{bulk/pw} = \frac{C_{bulk}}{C_{pw}}$$

Where:

$K_{bulk/pw}$ = Pore Water Partitioning Coefficient (L/kg)
C_{bulk} = Bulk Solid Phase Concentration (mg/kg)
C_{pw} = Pore Water Concentration (dissolved) (mg/L)

Equation 6-2 Organic Carbon Normalized Pore Water Partitioning Coefficient

$$K_{bulk-oc/pw} = \frac{C_{bulk-oc}}{C_{pw}}$$

Where:

$K_{bulk\text{-}oc/pw}$ = Organic Carbon Normalized Pore Water Partitioning Coefficient (L/kg)
$C_{bulk\text{-}oc}$ = Organic Carbon Normalized Bulk Solid Phase Concentration (mg/kg)
C_{pw} = Pore Water Concentration (dissolved) (mg/L)

Equation 6-3 *Lumbriculus* Partitioning Coefficient

$$K_{bulk/Lv} = \frac{C_{bulk}}{C_{Lv}}$$

Where:

$K_{bulk/Lv}$ = *Lumbriculus* Partitioning Coefficient
C_{bulk} = Bulk Solid Phase Concentration (mg/kg)
C_{Lv} = *Lumbriculus* Receptor Tissue Concentration (mg/kg)

Treatments were further evaluated to determine the level of treatment provided between sequestration agents by evaluating the relative change in partitioning between the pre- and post-treatment sampling events. Pore water partitioning factors and *L. variegatus* partitioning factors (BSAFs) were calculated by dividing the post-treatment partitioning coefficient by the pre-treatment partitioning coefficient (Equations 6-4 and 6-5). Larger partitioning factors represent enhanced treatment over the untreated condition. Temporal effects are not a factor although results from different sampling events may be considered with respect to time.

Equation 6-4 Pore Water Partitioning Factor

$$\Delta K_{pw}^{Tx} = \frac{K_{bulk/pw}^{Tx}}{K_{bulk/pw}^{To}}$$

Where:

ΔK_{PW}^{Tx} = Pore Water Partitioning Factor
$K_{bulk/PW}^{Tx}$ = Post-Treatment Pore Water Partitioning Coefficient T=x(L/kg)
$K_{bulk/PW}^{To}$ = Pre-Treatment Pore Water Partitioning Coefficient T=0 (L/kg)

Equation 6-5 *Lumbriculus* Partitioning Factor

$$\Delta K_{Lv}^{Tx} = \frac{K_{bulk/_{Lv}}^{Tx}}{K_{bulk/_{Lv}}^{To}}$$

Where:

ΔK_{Lv}^{Tx} = Macroinvertebrate Partitioning Factor
$K_{bulk/Lv}^{Tx}$ = Post-Treatment Macroinvertebrate Partitioning Coefficient T=x
$K_{bulk/Lv}^{To}$ = Pre-Treatment Macroinvertebrate Partitioning Coefficient T=0

6.1.4 $K_{bulk/pw}$ Evaluation of PCB Reduction in Bioavailability

PCB pore water partitioning coefficients ($K_{bulk/pw}$ and $K_{bulk\text{-}oc/pw}$) were calculated to normalize the data due to high spatial heterogeneity within the bulk phase across the treatment area. $K_{bulk/pw}$ calculations were observed to normalize data across the treatment area in the pre-treatment sampling event as well as between the three sampling events in the Control plots. Time 0 $K_{bulk/pw}$ values were normalized to within one order of magnitude as opposed to the pore water concentrations discussed previously, which ranged over five orders of magnitude in variation. The effects of organic carbon normalization were also considered. A comparison between the partitioning coefficients is presented in Table 6-3. The percent increase between Time 0 and Time 2 partitioning coefficients (i.e., reduced bioavailability) suggests that for evaluating treatment effectiveness, there is little difference between the traditional equilibrium partitioning approach that uses organic carbon normalization and the approach presented in this report except when considering that organic carbon normalization potentially underestimates the reduction in bioavailability because not all carbon sorbs HOCs equally effectively.

Table 6-3 Average Pore Water and Organic Carbon Normalized Pore Water Partitioning Coefficients

Treatment	Pore Water Partitioning Coefficient			% Increase between Time 0 and Time 2
	Time 0	Time 1	Time 2	
	K as C_{bulk}/C_{pw} *(L/kg)*			
Slurry Spray	4.20E+04	3.74E+05	3.05E+05	626%
AquaBlok®	5.21E+04	1.53E+06	1.49E+06	2754%
SediMite™	7.22E+04	2.85E+05	1.90E+05	163%
Sand Control	2.58E+05	3.67E+04	1.49E+05	-42%
Control	2.47E+04	9.82E+04	1.41E+05	472%

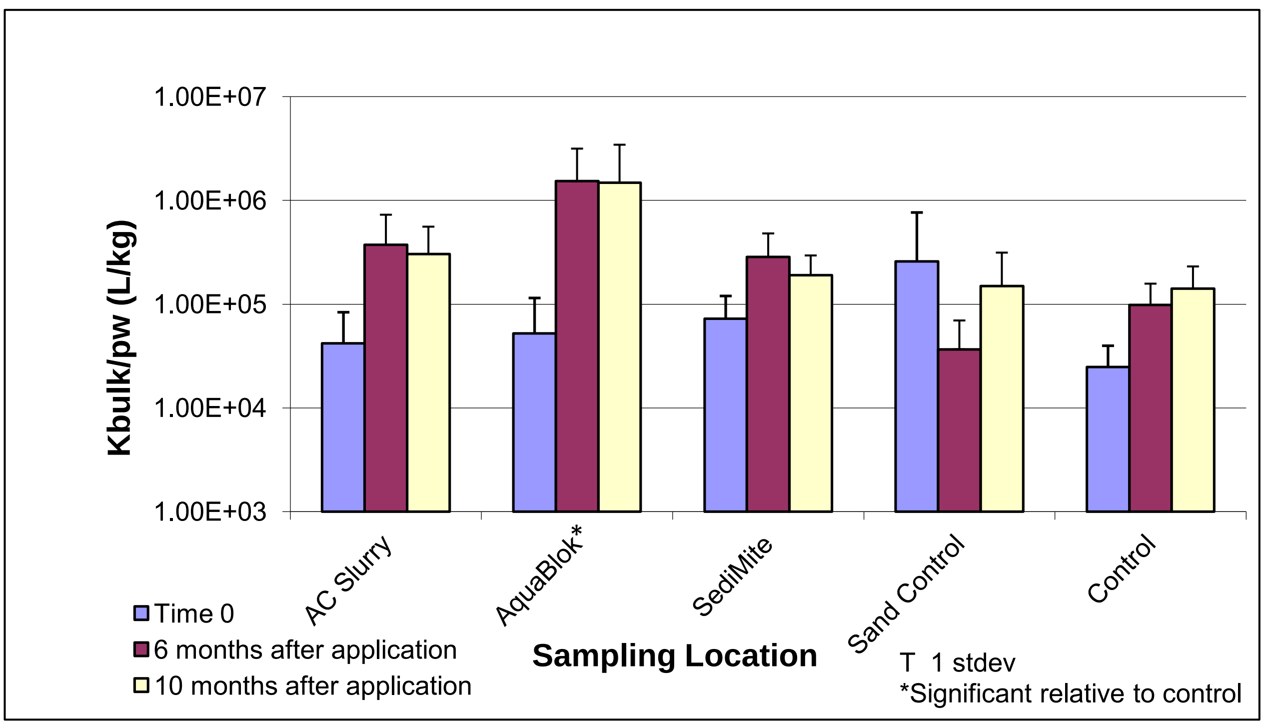
Table 6-3 Average Pore Water and Organic Carbon Normalized Pore Water Partitioning Coefficients (con't)

Treatment	Pore Water Partitioning Coefficient Time 0	Time 1	Time 2	% Increase between Time 0 and Time 2
	K as $C_{bulk\text{-}oc}/C_{pw}$ *(L/kg)*			
Slurry Spray	2.62E+05	2.82E+06	1.49E+06	467%
AquaBlok®	2.99E+05	9.26E+06	8.61E+06	2782%
SediMite™	4.12E+05	1.15E+06	6.55E+05	59%
Sand Control	1.65E+06	3.66E+05	9.36E+05	-43%
Control	1.89E+05	4.84E+05	8.25E+05	335%

K= partitioning coefficient

Figure 6-1 presents the results of the $K_{bulk/pw}$ evaluation. AquaBlok® treatments exhibited the highest average post-treatment partitioning ($1.5 \times 10^{+06}$), followed by the Slurry Spray ($3.4 \times 10^{+05}$), SediMite™ ($2.4 \times 10^{+05}$), Control ($1.2 \times 10^{+05}$) and Sand control ($9.3 \times 10^{+04}$). ANOVA testing determined that the addition of AC was a statistically significant variable in $K_{bulk/pw}$ ($F = 4.250$, $p = 0.0033$, d.f. = 4). A Student's T-test determined that AquaBlok® provided statistically significant greater partitioning than the Control ($p = 0.0034$). The Slurry Spray and SediMite™ treatments and the Control also indicate a non-statistically significant increase in $K_{bulk/pw}$ over time. Logarithmic transformations were conducted to normalize the data. Statistical evaluation outputs are presented in Appendix D.

Figure 6-1 PCB Sediment: Pore Water Partitioning ($K_{bulk/pw}$) by Treatment



Changes in partitioning (partitioning factors) were also compared within the same treatments for pre- and post-treatment application. An average increase in ΔK_{PW}^{Tx} was observed for all applied treatments between the pre-treatment and post-treatment sampling events. A slight average increase in the partitioning factor was observed within the Control plots while slight decreases were observed in the Sand control plots. The largest average positive change in the $K_{bulk/pw}$ was observed for the AquaBlok® treatment, with an averaged ΔK^{Tx}_{pw} of 41.6. The next largest partitioning factor was within the Slurry Spray treatment (9.9), followed by the Control plots (4.8) and SediMite™ (3.8). An average decrease in the pore water partitioning coefficient was observed in Sand control between the pre- and post-treatments (ΔK^{Tx}_{pw}=0.9).

Individual ANOVAs were conducted within each treatment between pre- and post-treatment applications. Analysis determined that Time 0 $K_{bulk/pw}$ was statistically significantly different from both Time 1 and Time 2 sampling for the AquaBlok®, Slurry Spray treatments and Control (no treatment). Pore water partitioning coefficients in the Sand control and SediMite™ plots were not found to be statistically different between Time 0 and Times 1 and 2, although the SediMite™ plots did show a slight increase in $K_{bulk/pw}$ between Time 0 and Time 2.. A logarithmic transformation of the data was required to provide a normal distribution prior to analysis. Results of the statistical analysis are provided in Table 6-4 and evaluations are shown in Appendix D.

Table 6-4 ANOVA Analysis of Time 0, Time 1, Time 2 $K_{bulk/pw}$ Within Each Treatment

Treatment	F Ratio	Probability (>*p*)	Degrees of Freedom	Significant Variance
Slurry Spray	3.81	0.048	2	Yes
AquaBlok®	16.59	<0.001	2	Yes
SediMite	3.19	0.078	2	No
Sand Control	1.06	0.371	2	No
Control	4.92	0.026	2	Yes

Because the Control exhibited a statistically significant increase in $K_{bulk/pw}$, a second statistical analysis was conducted to evaluate the significance of $K_{bulk/pw}$ observed in the treatment plots versus that observed in the Control. Dunnett's method was used to evaluate the partitioning factors of the treatments to the Control. The analysis determined that the AquaBlok® provided statistically significant greater solid phase partitioning than the Control. The reasons for increased solid phase partitioning in the Control are not understood at this time.

6.1.5 Evaluation of Pre- and Post-Treatment *Lumbriculus* Concentrations

An ANOVA analysis on post-treatment *Lumbriculus* receptor tissue concentration data collected from 28-day bioaccumulation studies by treatment type (AquaBlok®, Control, Sand control, and Slurry Spray) determined that treatment type was a statistically significant variable for tissue concentration. Student's T means statistical comparison determined that the AquaBlok® and Slurry Spray were statistically different from the Control. Dunnet's mean statistical comparison (with Control set as the control) confirmed that AquaBlok® and the Slurry Spray were both

statistically different than the Control. ANOVA analysis on pre- and post-treatment tissue concentrations just within the Control showed that they were weakly statistically different. Table 6-5 summarizes the results of significance in tissue concentrations between pre- and post-treatment for the treatment types. Statistical evaluation outputs are presented in Appendix D.

Table 6-5 ANOVA Analysis of Pre- and Post-Treatment *Lumbriculus* Receptor Tissue Concentrations Within Treatment Types

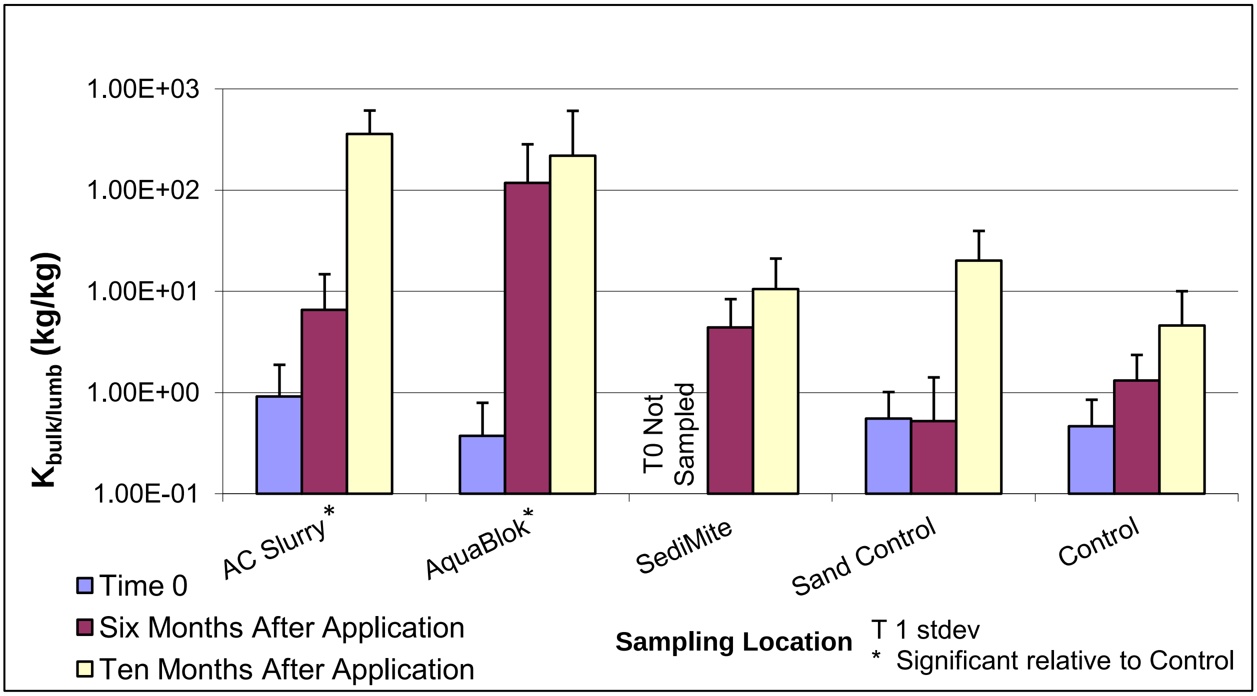
Treatment	F Ratio	Probability (>*p*)	Significant Variance
Slurry Spray	4.3115	0.0583	Weakly
AquaBlok®	43.3589	<0.0001	Yes
SediMite™	*Not measured*	*Not measured*	*NA*
Sand Control	1.1268	0.3094	No
Control	4.0309	0.0699	Weakly

6.1.6 $K_{bulk/Lv}$ Evaluation of PCB Reduction in Bioavailability

Large variations were observed in the pre-treatment macroinvertebrate receptor tissue concentrations over the treatment area (>10^4). Therefore, *L. variegatus* partitioning ($K_{bulk/Lv}$) was also employed to evaluate the efficacy of sequestration agents in reducing PCB bioavailability as measured from laboratory bioaccumulation testing. The application of *L. variegatus* partitioning normalized the pre-treatment data to a range less than one order of magnitude.

The results of the *L. variegatus* partitioning evaluation were similar to the pore water results for the treatment plots (Figure 6-2). Although not statistically significant, an increase in the post-treatment mean $K_{bulk/Lv}$ was observed for all treatments and control plots. The largest average $K_{bulk/Lv}$ was observed in the AquaBlok® treatments (312 kg/kg), followed by Slurry Spray (121 kg/kg), Sand control (9.87 kg/kg), SediMite™ (8.76 kg/kg) and lastly, the Control (2.51 kg/kg). ANOVA testing determined that treatment was a statistically significant variable in *L. variegatus* partitioning ($F = 12.59$, $p \leq 0.0001$, d.f. = 4). Additionally a Student's T-test determined that the AquaBlok® and Slurry Spray treatment provided statistically significant greater partitioning than the Control ($p \leq 0.0001$ for both). Logarithmic transformations were conducted to normalize the data. Results of the statistical evaluation are presented in Appendix D.

Figure 6-2 PCB $K_{bulk/Lv}$ by Treatment



Individual ANOVAs were conducted within each treatment between pre- and post-treatment applications. Analysis determined that all pre-treatment *L. variegatus* partitioning was statistically significantly different from both Time 1 and Time 2 post-applications sampling. No Time 0 SediMite™ results were available so SediMite™ was excluded from the analysis (although the Time 1 and Time 2 measurements indicate a non-statistically significant increase in the $K_{bulk/Lv}$ over time). A logarithmic transformation of the data was required to provide a normal distribution prior to analysis. Results of the statistical analysis are provided in Table 6-6.

Table 6-6 ANOVA Analysis of Time 0, Time 1, and Time 2 $K_{bulk/Lv}$ Partitioning Coefficients within Each Treatment

Treatment	F Ratio	Probability (>*p*)	Degrees of Freedom	Significant Variance
Slurry Spray	85.27	<0.0001	2	Yes
AquaBlok®	22.12	0.0008	2	Yes
Sand Control	11.99	0.0047	2	Yes
Control	9.512	0.0104	2	Yes

Because a treatment effect was measured within the Control, a second statistical analysis was conducted to evaluate the degree of treatment provided between the different treatments. Dunnett's method was also applied to statistically compare the partitioning factors of the

treatments to the Control. The analysis determined that the AquaBlok® and the Slurry Spray provided a statistically significant $K_{bulk/Lv}$ greater than the Control.

6.1.7 Treatment Efficacy Discussion

Increases in bulk soil PBCs were measured between pre-treatment and post-treatment events and the measured concentrations ranged orders of magnitude. This is likely due to heterogeneity in PCB distributions across the entire site. Post-treatment black carbon content was statistically significantly different from baseline conditions in only the Slurry Spray and Aquablok® plots and only Aquablok® had statistically significantly different pore water concentrations from baseline conditions. Slurry Spray, AquaBlok®, and the Control plots had weakly statistically significant or statistically significant decreases in *Lumbriculus* tissue concentrations. Because of the heterogeneity in the soil and black carbon results and the lack of clear trends in pore water and tissue concentrations, the overall program did not conclusively demonstrate treatment efficacy (PCB bioavailability). However, the overall program results suggest that additions of activated carbon can sequester PCBs and the active *in situ* remediation technologies tested in this project could be effective for the remediation of contaminated wetland sediments. Additional long term monitoring would be necessary to complete the efficacy evaluation.

While general trends were observed in PCB bioavailability, changes observed in the Control and uncertainty in the mixing zone confound interpretation of treatment efficacy. General decreases were observed in PCB bioavailability as evidenced by the partitioning between pore water to bulk soil and tissue to bulk soil as a result of AC addition via the treatment technologies. Additionally, statistical evaluations determined that AquaBlok® and the Slurry Spray treatments provided significantly enhanced treatment in comparison with the Control. While these initial findings are promising and provide evidence that PCB bioavailability is reduced as a result of the application of these AC treatments, partitioning fluctuations within the Control plots raise questions about the degree of treatment efficacy observed in this study as well as the fate of AC in the natural system.

Treatment results demonstrated that AquaBlok® and the Slurry Spray performed statistically significantly with respect to the Control; however, uncertainties about mixing mechanisms at the site means that more evaluation is needed to demonstrate effective incorporation of treatment into the soil and long term efficacy. Qualitative observations from cores suggest that benthic mixing may not dominate at the site; rather, root mixing may be the primary mechanism. Therefore, treatment design depths and monitoring depths may not have been congruent for optimal evaluation of treatment efficacy. Longer term monitoring may be advantageous to understanding the rates and depths of mixing in this system. Additionally, differences between amendment design thickness and deployed thicknesses should be further investigated. Overall, AC technology has been demonstrated to be working, but the mechanisms affecting the outcomes of the different treatment methods are not fully understood. Mixing zone analysis, further exploration of field variables, and long term monitoring is necessary before further conclusions can be drawn.

An increase in both $K_{bulk/pw}$ and $K_{bulk/Lv}$ was observed within the Control plots between pre- and post-treatment applications although no treatment was applied to these plots. Black carbon measurements did not show an increase in AC between the sampling events (e.g., from potential migration of AC between plots or atmospheric inputs) that could explain this trend. Similar observations were made in the Sand control plots. A potential explanation of this variance may be

attributed to the sampling protocol followed in this study. Composite samples were collected by combining spatially distributed grab samples from the top 15 cm (6 in.) of soil that were homogenized in the field prior to all analytical analyses in an attempt to account for geospatial heterogeneity across the treatment plot. However, the vertical heterogeneity of PCB concentrations with depth in the BAZ, with or without treatment, is not well understood and the heterogeneity is not understood through time (i.e., effects of mixing, sampling error). Therefore, the sampling approach may have introduced unintended artifacts that are currently not fully understood. In addition, homogenization likely artificially increased the distribution of amendments within the sample. The natural integration of amendments is important to the exposure of benthos and long term stability of the amendments, particularly at this site where there is a large concentration gradient with depth (concentrations increase over an order of magnitude from the surface to 15 cm (6 in) depth). As a result, an understanding of the natural mixing processes (e.g., hydrologic, biologic) that integrate the different AC treatment products into the surficial soils and the rates of mixing is a data gap and will require further evaluation to fully characterize the efficacy of the different AC products.

In addition to the aforementioned challenges in efficacy evaluation, the depth of the apparent BAZ is a data gap at this site but can be estimated based on field observations of rhizome depth. Common reed rhizome depths of 4 to 8 inches were reported in Delaware (Gallagher et al., 1979) but depths can vary greatly with site conditions (USDA Forest Service, 2013 accessed at http://www.fs.fed.us/database/feis/plants/graminoid/phraus/all.html). The assumed BAZ thickness and subsequent soil sample interval was 15 cm (6 inches) in this study. However, the potential effects of such a data gap can be estimated. If the apparent BAZ was over-estimated in this study by sampling deeper, then proportionally less AC would be sampled with depth, PCB concentrations in pore water presumably would be higher, since less binding capacity of AC exists. Conversely, if the sampled interval was shallower than the apparent BAZ, higher proportional concentrations of AC would be present and the opposite condition ($K_{bulk/pw}$ is artificially higher) would result. High resolution soil and vertical pore water profiling and a thorough pre-treatment characterization of the BAZ may be advantageous to resolve this potential question.

Ghosh et al. (2011) identify several challenges in evaluating efficacy due to transient changes that take place in the environment, which differ from controlled laboratory settings. Potential confounding factors include: contaminated water above the treatment zone, inwash and deposition of contaminated sediment into the treatment area, mixing conditions, and small-scale heterogeneity of sorbent distribution. Thus, longer term evaluations that use multiple lines of evidence are desirable.

6.2 ECOLOGICAL EFFECTS

Ecological monitoring metrics were evaluated against the performance criteria described in Section 3. Resident plant community survival, health, and plant nutrient uptake, and benthic invertebrate survival and health were assessed.

6.2.1 Vegetation Evaluation

In general, the results of statistical analyses suggest that there was no effect of treatment on plant species composition within the field demonstration wetland. However, longer term monitoring would elucidate treatment effects and perhaps clarify natural temporal and spatial variations.

Strong correlations were observed between pre and post-treatment plant metrics. No differences were observed among treatments and controls for relative cover and species richness within Time 0, Time 1 and Time 2 sampling events. Lower diversity (marginally statistically significant) was observed within post-treatment SediMite™ plots when compared to the Control plots. However, this may be attributed to natural variation as diversity, and species richness also tended to be lower within SediMite™ plots prior to any treatments (i.e., at Time 0) than the in Control plots. It may also be a physical effect due to thicker than designed deployment in the SediMite™ plots but that is seemingly unlikely given that SediMite™ thickness was thinner than other treatments (AquBlok® and Sand control). Although mean relative cover and species richness within treatment plots appeared to be lower at Time 0 when compared to Time 1 and Time 2, these observed differences may be temporal in nature. Aboveground portions of most soft, fleshy herbaceous and aquatic emergent species completely disappear following the first frost, which can result in a substantial decrease in plant community structure in a short time period (e.g., between October when the Time 2 sampling event took place and November when the Time 0 sampling event took place).

Visual inspections of vegetation during each of the post-treatment sampling events did not identify any early senescence, yellowing or stunting of vegetation. However, in June 2011, dark staining was observed on newly emerged vegetation (sensitive fern [*Onoclea sensibilis*]) in plots treated with AquaBlok® at Time 1. Because Canal Creek is tidally influenced, it was presumed that the dark colored, fine-textured component of the AquaBlok® was transported with the rising tide, staining portions of the plants that were submerged. The dark staining on the leaf surfaces could potentially temporarily impact the photosynthesis process and gas exchange between the leaf surface and atmosphere via stomata.

6.2.2 Plant Nutrient Evaluation

Several statistical comparisons were conducted on the plant tissue concentrations and are presented in Appendix F; however, due to the variability in the concentrations of the metals and nutrients in the soils an evaluation of plant uptake factors may be more relevant to the objectives of this demonstration project.

Uptake factors for each replicate and metal or nutrient were calculated on a dry weight basis by dividing the plant tissue concentration by the soil concentration. Plant tissue data were available for each replicate of each treatment and soil concentrations were available for each treatment (the soil from all replicates of a treatment were combined at test termination and submitted for chemical analysis). Hypothesis testing was conducted to determine statistical differences, either higher or lower, relative to the APG-15 (Site Control) sample and the lab control. Table 6-7 and Figure 5-19 summarize the findings of this evaluation.

The majority of the treatments showed statistically significantly lower uptake factors relative to the lab control uptake factors. However, this is not necessarily unexpected since the lab control material was a test soil mixed in the laboratory from sphagnum peat, clay, sand, and calcium carbonate. This material has relatively low TOC (2.8%) and is unlikely to significantly bind the materials in the nutrient solution; therefore, the nutrients are expected to be incorporated into the plant tissues in the lab control. Only sodium uptake factors were higher in the treated soil. Treated soils had higher sodium levels (99 to 327 mg/kg) than the lab control (Not detected at a reporting limit of 61.1 mg/kg), but that does not explain the higher accumulation in the tissues from the treated soil.

An evaluation of uptake factors relative to the APG-15 (Site Control) sample are likely more relevant to the objectives of this project since all of the samples were obtained from the wetland and represent natural soils with higher TOC levels (ranging from 6.4% to 15.5%). Table 6-3 shows that many of the uptake factors in the three treated soils were not statistically different from the APG-15 sample. This indicates that uptake of nutrients and metals was not changed by the addition of the treatments in these locations. Only nitrogen uptake in the APG-02 Slurry Spray treatment and sulfur uptake in the APG-16 SediMite™ treatment were statistically less than uptake in the APG-15 sample. For the remaining evaluations, the uptake factors were statistically higher in the treated soils than in the APG-15 sample.

These findings indicate that the treatments are generally not likely to impair the uptake of nutrients and metals into plants in treated wetlands. It is possible that higher than normal uptake of nutrients or metals could eventually adversely impact plants. However, the addition of a nutrient solution during the test represents an additional highly bioavailable source of metals and nutrients beyond what is naturally present in the soils and may over-estimate plant uptake under field conditions.

6.2.3 Macroinvertebrate Evaluation

Simple statistics comparing differences in diversity scores of replicate means between control and treatment plots were attempted and yielded little information due to a paucity of organisms. The lack of a significant benthic community at the Site, including in control plots, is likely due to habitat limitations in the marsh environment sampled for this demonstration project.

Table 6-7 Summary of Statistical Significance of Plant Uptake Factors Relative to Site and Laboratory Controls

Treatments vs Lab Control						Treatments vs APG -15 Site Control			
	APG-02 Slurry Spray	APG-06 AquaBlok®	APG-15 Site Control	APG-16 SediMite			APG-02 Slurry Spray	APG-06 AquaBlok®	APG-16 SediMite
Boron	NS	-	-	-		Boron	+	+	NS
Calcium	NS	NS	-	NS		Calcium	+	NS	+
Copper	-	-	-	-		Copper	+	+	NS
Iron	-	-	-	-		Iron	NS	NS	NS
Magnesium	-	-	-	-		Magnesium	+	+	+
Manganese	-	-	-	-		Manganese	+	NS	NS
Phosphorus	-	-	-	-		Phosphorus	+	+	NS
Potassium	-	-	-	-		Potassium	+	+	NS
Sodium	+	+	+	+		Sodium	NS	NS	NS
Sulfur	-	-	-	-		Sulfur	NS	NS	-
Zinc	-	-	-	-		Zinc	+	+	NS
Nitrogen	-	-	-	-		Nitrogen	-	+	NS

NS Not significant

+ Treatment is statistically significantly greater than Control

- Treatment is statistically significantly less than Control

6.3 PERFORMANCE EVALUATION

The performance of each treatment was assessed by comparing treatment cost, implementability, and constructability metrics. A more detailed evaluation of cost performance is provided in Section 7.

6.3.1 Cost

Treatment costs were compared to costs for a more traditional remedial approach (removal and wetland restoration) to evaluate the success of the demonstration. Specifically, a present value cost-savings of greater than 30-50% compared to removal and wetland restoration would represent a successful demonstration. Results of the cost analysis are presented in Section 7.3. The cost analysis shows a projected potential cost savings of 20 to 60% on a per acre basis depending on several variables including, but not limited to the size of the site, type of wetland, depth and type of impacts, type of amendment and site accessibility.

6.3.2 Implementability

The implementability of the treatment technologies was evaluated based on material application rates, equipment limitations, reliability and scalability.

Pelletized Activated Carbon

The field demonstration confirmed that AquaBlok® could be deployed effectively utilizing a bark-blower, with some limitations. The deployment rate of the AquaBlok® for each plot was highly dependent on the distance the plot was located from the bark-blower. Deployment duration of the AquaBlok® at various distances are summarized in Table 5-2, with rates ranging from 1.24 tons per hour (tph) with 200 linear feet (lft) of hose to 2.15 tph with 100 lft of hose. It should be noted that these deployment rates included a considerable amount of manual labor to address clogging issues which occurred in the deployment hose. Because of uneven terrain, the hoses would tend to clog at low spots requiring manual labor to restore production. The AquaBlok® pellets were 5% activated carbon by mass, so the effective activated carbon rate ranged from 124 pounds activated carbon per hour (lbcph) with 200 lft of hose to 215 lbcph with 100 lft of hose. These deployment rates included the time to load the bark-blower with AquaBlok® from super-sacks, which was minimal since the bark-blower hopper could hold approximately two tons of AquaBlok®.

A two inch and a four inch hose were provided by the vendor for use with the bark blower; however the two inch hose regularly clogged at the cam lock connection between each hose section making the four inch hose the preferred diameter. The effective range of the bark blower with the four inch hose was approximately 100 to 200 lft. At greater distances, the deployment rate of the AquaBlok® was significantly reduced and clogging became more problematic. Due to this distance restriction, a proposed Control plot (APG-20) and a proposed AquaBlok® plot (APG-15) were switched. An additional 300 pounds (approximately 1/8 of a super-sack) were deployed by hand evenly to each of the plots to achieve the final desired AC mass per plot. This relatively small quantity was delivered by hand as it was determined to be impractical to deploy 300 pounds of material via the bark blower.

Based on the results of the field demonstration, the deployment of pelletized activated carbon utilizing a bark-blower is feasible for scalability; however consideration with regard to site access and deployment distances is required. The bark-blower is much more effective when being utilized at close distances (within 100 lft from the piece of equipment), with optimal deployment distances of up to 50 lft.

Alternative delivery mechanisms which may be more efficient in deploying material include a Stoneslinger or Putzmeister Telebelt which would improve production rates, but may require additional consideration with regard to site access and site preparation, including the installation of stabilized construction access roads and staging areas as required. Also, the mobilization cost for this equipment is more significant than for a bark-blower; however, this cost will be off-set by increased production rates, so the scale of the project will be a consideration in equipment selection.

Similar results were obtained for SediMite™ deployment. The SediMite™ was deployed using a turf spreader for the coarse application and a Vortex for touch-up. The application rate, using a Vortex spreader, was 10 lbs/minute, and the turf spreader was 150 lbs/min.

Powdered Activated Carbon Slurry

The field demonstration confirmed that the powdered activated carbon could be effectively deployed utilizing standard hydro-seeding equipment. The PAC slurry application via hydro-seeder took approximately 15 minutes per plot, as compared to two hours per plot for the AquaBlok®. The effective carbon deployment rate was 1,200 lbcph, six to ten times higher than for AquaBlok®. This deployment method proved effective at delivering the carbon slurry to distances up to 150 lft without compromising production rates and/or the quality of the slurry. As such, it is anticipated that the deployment distance could increase substantially (i.e. up to 500 lft), if required with minimal impacts to cost and deployment rates.

Based on the results of the field demonstration, the hydro-seeding equipment utilized was very effective in deploying the powdered activated carbon slurry at significant distances from the staging area. This type of deployment equipment is readily available and can be utilized in several ways to minimize disturbance to resource areas (truck mounted equipment or delivery hose extending from the equipment). As such, this delivery technique is considered to be scalable for larger applications.

Sand Mixture

The field demonstration identified limitations with regard to the use of the bark-blower for deploying the sand mixture. Deployment activities were suspended during the application of the sand mixture to APG-10 when air temperatures dropped below freezing, causing the sand mixture to freeze and clog the bark-blower's air-lock and hoses. On the final day of deployment, frozen sand in the bark-blower's hopper/air lock chamber resulted in damaged shear pins in the conveyor belt, rendering the piece of equipment inoperable. As a result, the remaining sand was deployed by hand.

Approximately 15 trips over a 50 minute period were required to deploy the remaining sand mixture (approximately one ton) to Plot #14. There was a relatively straight and frozen wetland

path from the sand mixture loaded super-sack to the plot. The remaining sand plots (#1 and #10) required 55 trips per plot, over a period of approximately 100 and 105 minutes. The plots were approximately 100 and 200 lft from where the super-sacks were positioned. Plot #10 required a 120 lft traverse through the wetlands, and with the frozen conditions present, allowed for wooden planks to be utilized as walkways during deployment activities. However, as the tide came in and the water level in the wetlands rose, the frozen surface gave way to softer/unstable conditions and the water made the wooden planks slippery. Although the application duration/rate for Plot #1 (located approximately 100 lft from where the super-sack was positioned), was similar to Plot #10, the deployment/application rate would not be sustainable over multiple days of deployment due to the physical strain experienced by the deployment crew.

The sand application rate using the bark blower with hose lengths similar to those used during AquaBlok® deployment was 25% less than the application rate of the AquaBlok® (based on deployment activities in APG-3 prior to equipment malfunction). Refer to Table 5-3 for a summary of sand deployment operations using a 100 lft hose. Deployment rates for the sand mixture were approximately 1.63 tph. The effective carbon content of the sand mixture was approximately one percent and the effective carbon deployment rate for sand was 32.6 lbcph.

Based on the results of the field demonstration, the deployment of the sand mixture utilizing a bark-blower may be feasible depending on the moisture content of the sand mixture and ambient temperatures at the time of deployment. However, should this be determined to be practical under desirable conditions, consideration with regard to site access and deployment distances is required. Alternative delivery mechanisms may include the use of a Stoneslinger or Putzmeister Telebelt which would improve production rates, but may require additional consideration with regard to site access and site preparation, including the installation of stabilized construction access roads and staging areas as required. Also, the mobilization cost for this equipment is more significant than for a bark-blower, although this cost will be off-set by increased production rates, so the scale of the project will be a consideration in equipment selection.

6.3.3 Constructability

The constructability of the treatment technologies was evaluated based on **v**isual observations of application homogeneity and measurements of sequestration agent thickness. Measurements were made in each of four quadrants of a plot. Table 5-3 presents the homogeneity of application thickness.

AquaBlok® amendment was placed 2.14 inches thick on average, varying by 0.2 inch, whereas sand amendment was 1.99 inches thick on average, varying by 0.2 inch. Slurry thickness was not measured because the application was a thin veneer. The SediMite™ amendment was placed with an average thickness of about 1.25 cm (0.5 inches).

6.4 TECHNOLOGY ACCEPTANCE

The acceptance of the technology was assessed via the permitting process, work plan review, and peer-reviewed publications/conference presentations.

6.4.1 Permits

The USACE issued a Water Quality Certification permit authorizing the demonstration construction activities in a floodway. The USACE determined that the activities undertaken for the demonstration project did not constitute permanent placement of fill however, site-specific permit evaluations that consider state and local laws, land or waterway use (e.g. recreation), or timing of construction activities (e.g. seasonal wildlife restrictions) should be completed early in the planning process. These factors that may cause restrictive conditions or schedules can usually be planned for and mitigated against, as with any remediation construction. Thus, the technology is acceptable to regulators.

It was also determined for this project that a local county soil conservation district permit was not required due to the demonstration project's location on Federal Lands. Other projects may have additional permitting requirements.

6.4.2 Work Plan Review

The Demonstration Plan was reviewed and approved by state Maryland Wildlife Management Area (MWMA) and federal (USACE) agencies prior to implementation. Regulators routinely review remediation construction work plans. The approval by regulators for construction work plans and their implementation of remedy technologies provides the technology and the Demonstration Plan's design a level of acceptance that validates the technology.

6.4.3 Industry

The majority of relevant peer reviewed studies have focused on sediments, soils, and groundwater, rather than hydric soils. Organoclays, zeolites, and activated carbon have been used extensively for the treatment of water and soil contamination (McDonald et al., 2004). DoD's Strategic Environmental Research and Development Program (SERDP) and ESTCP have funded and are currently funding a number of projects that focus on the use of amendments to sediment or to sediment caps to manage contaminated sediments *in situ* (visit *http://www.serdp-estcp.org/Program-Areas/Environmental-Restoration/Contaminated-Sediments/* for additional information*)*. These include ER-0510 "Field Testing of Activated Carbon Mixing and *In Situ* Stabilization of PCBs in Sediment," ER-0433, "An Innovative Capping Material for Contaminated Sediments," ER-1207 "In-situ Stabilization of Persistent Organic Contaminants in Marine Sediments," ER-1491 "Rational Selection of Tailored Amendment Mixtures and Composites for In-Situ Remediation of Contaminated Sediments," ER-1501 "Innovative In-Situ Remediation of Contaminated Sediments for Simultaneous Control of Contamination and Erosion," and ER-1493 "Reactive Capping Mat Development and Evaluation for Sequestering Contaminants in Sediments".

Although *in situ* subaqueous sediment and wetland remedial technologies have been successfully field demonstrated at a number of sites in the past decade (e.g., see Patmont et al., 2013), longer-term (i.e., longer than 10 years) studies relative to remedial efficacy are currently lacking. Thompson et al. (2012) identified the greatest needs to promote active *in situ* treatment acceptance by stakeholders as a viable remedy are long-term proof of effectiveness and permanence. Patmont et al. (2013), presents a summary of completed and ongoing AC and biochar pilot projects, many of which have been conducted in wetland settings. Although not yet widely applied, *in situ*

remediation of contaminated hydric soils is likely to be viewed positively by industry as less invasive technologies continue to be developed.

6.5 SAFETY

Approximately 600 hours were spent in the field injury free and more than 1000 hours were spent in the laboratory injury free. Safety observations were reported during the field activities and investigation derived waste (IDW) was managed in accordance with the HASP. Observations noted the presence of deer ticks in the wetlands, potential cold weather exposure, and stop work conditions related to high water and inclement weather. No activities were modified or stopped due to technology-related hazards.

6.6 TECHNOLOGY TRANSFER

Technology transfers were completed on the following dates and in the forums indicated in addition to several internal NAVY technology transfers:

- February 2009- Navy and Marine Corps Cleanup Conference
- January 2010- AECOM webinar to waterway restoration practitioners
- November 2010- Briefing presentation to ESTCP Program
- February 2011- Battelle International Conference on Contaminated Sediments presentation to professionals
- November 2011- SETAC poster presentation to professionals
- December 2011- AECOM webinar to waterway restoration practitioners
- May 2012- AECOM webinar to waterway restoration practitioners
- October 2012-Installation Briefing presentation to Aberdeen Proving Ground
- February 2013- Battelle International Conference on Contaminated Sediments presentation to professionals
- April 2013- Presentation to the Navy NAVFAC Sediment Workgroup

Future opportunities for technology transfer are being sought and may include published technical guidance documents, peer-reviewed professional journal articles and presentations, or similar venues in collaboration with the ITRC.

7.0 COST ASSESSMENT

A cost assessment was performed to summarize cost tracking and to provide order-of-magnitude costs for full scale application of the technologies described in this report. Costs that were tracked for the demonstration project are not directly scalable to an implementation project due to the research nature of the demonstration. For example, labor costs for implementation and monitoring were much more intensive than would be expected for a full scale project. The material and labor requirements to lay out the 24 test plots and the high frequency of sample collection, data evaluation, and reporting are above the costs that would be encountered to treat a 5 acre plot. Therefore, costs reported in the literature are provided as the basis for the cost model for full scale application. Tracked costs are presented in Table 7-1. The cost estimates presented herein can be used to compare *in situ* wetland remediation to more conventional remedial technologies such as source removal and restoration. Ghosh et al. (2011) and Patmont et al. (2013) have presented cost estimates for the application of *in situ* remediation by AC, which compare favorably to cost estimates of dredging and disposal. For example, costs of dredging the Hudson River have been reported to be $15M per ha ($6.1M per acre) for phase I of the clean up (Hill, 2010 as cited by Ghosh et al., 2011) but costs for active *in situ* treatment by AC are an order of magnitude or more lower, ranging from $150,000/ha to $0.5M/ha [$60,000 to $200,000 per acre (Patmont et al., 2013)].

Table 7-1 Tracked Demonstration Project Elements and Costs

Cost Element	Element Components	Demonstration Cost, $K
Treatability Study	Labor Materials Analytical laboratory costs	$42
Permitting	Applications and Plans Meetings	$15
Mobilization	Access Road, Dry/Wet Deployment Roads Shipment of equipment and supplies	$28.5
Material Cost (Amendment)	Material cost (including manufacturing) Shipment of material	$27.3
Implementation	Equipment Rentals Labor (amendment deployment and application thickness confirmation measurements)	$119.1
Demobilization	Access Road, Dry/Wet Deployment Roads Restoration Shipment of equipment and supplies	$10
Long-term Monitoring	Travel and labor (sampling and field surveys) Shipment of equipment and supplies Laboratory costs	$215
Professional Services	Work Plans, Reporting, Management and Technical Transfers	$306.6

Wetland site variables such as the size and type of wetland requiring remediation, access, vegetation conditions, topography, water level conditions, and other site conditions may necessitate a broad variety of approaches in the method and types of deployment equipment for *in situ* remediation. Several factors require consideration for the full scale application of this technology, one of the most limiting of which is potential site access. Site access may significantly affect cost as follows:

Scenario 1: Equipment can deploy amendments to wetland from adjacent upland areas such that access roads or swamp mats will not be required within the wetland.

Scenario 2: Equipment will require access roads or swamp mats within wetland areas in order to deploy amendments.

Therefore, a significant portion of the construction cost can be associated with equipment mobilization and site preparation. The cost per acre for mobilization and site preparation decreases as the treatment area increases. As such, example costs are presented for three different size wetland areas (1, 5 and 10 acres).

Lastly, existing equipment available in the marketplace can readily be adapted to deploy treatment products to wetland hydric soils. Examples of four different deployment options include those discussed previously in Section 5: a bark blower, stone slinger, telebelt and hydro-seeder. Several other options exist for deployment equipment for sites with challenging access issues, including the use of barges and/or helicopters or other equipment; however, these installation methods were considered to be atypical situations for wetlands access, and as such, cost estimates presented herein do not include those process options.

7.1 COST MODEL

Table 7-2 presents a cost summary for the full-scale implementation of this technology assuming the typical scenarios described above. Major cost elements related to the technology and the data that were tracked to estimate costs associated with these elements are listed in the table. The assumptions associated with these elements are described in the following sections. It should be noted that design and permitting costs were not included as these costs are assumed to be consistent regardless of the selected remedy (traditional removal vs. in-situ sequestration).

7.1.1 Treatability Study and Remedial Design

A Treatability Study will often be required to determine the type(s) of amendments to be used for full scale application as well as the optimal application rate(s) needed to effectively sequester contaminants. Costs for this study will typically vary by contaminant, monitoring metrics, surface area of a site, number of different soil types at site, and other site-specific variables. Costs for certain organic compounds (e.g., high resolution PCB congener analysis) are expected to be of a higher magnitude than typical costs to assess the bioavailability of inorganics (e.g. metals and acid-volatile sulfides/simultaneously extracted metals analyses). The Treatability Study will typically be comprised of laboratory testing using site specific materials and available amendments. The results from the Treatability Study will be used as a basis for full scale design and implementation.

Components of a typical Treatability Study include:

1. Preparation of a site specific work plan to be approved by relevant stakeholders to reach consensus on performance criteria,
2. Phased laboratory work which may include an evaluation of amendment effectiveness, amendment dose optimization, and bioassays such as toxicity testing or bioaccumulation studies, and
3. Preparation of a report detailing the findings of the study, as well as recommended paths forward for implementation.

The potential costs for the treatability study may also vary depending on the density or frequency of sampling, the suite of analytes and the number and type(s) of amendments tested but typical costs for a wetlands site are expected to be $20,000 to $50,000. For example, treatability study costs presented in Table 7-1 for this project included laboratory costs for analyzing pore water, hydric soil, and macroinvertebrate tissue samples for soil treated with three different amendment types. Costs may be higher with larger sized sites if densely sampled but the laboratory costs are expected not to vary much from the estimate presented here.

7.1.2 Permitting

Because the technologies described in this Final Report include the introduction of fill to a resource area (albeit a minimal quantity of fill), federal permitting (e.g., USACE, Section 404 of the Clean Water Act) and possibly State/local permitting may be required. Because this permitting may also be required for more conventional remedial approaches (such as source removal), and because these costs are fairly well documented and do not vary significantly based on the technology employed, permitting costs were not included in this cost model, but should be planned for when evaluating this technology. Cost elements may include application and review fees, generation of maps and site information, and stakeholder meetings. Costs tracked for permitting related activities are presented in Table 7-1.

Table 7-2 Cost Estimate for *In Situ* Contaminant Sequestration in Wetland Hydric Soils

Cost Element	Element Components	Cost per Treatment Area (acres)[1]		
		1 Acre	5 Acre	10 Acre
Treatability Study	- Labor - Materials - Analytical laboratory costs	\$20 - \$25	\$25 - \$50	\$25 - \$50
Mobilization	- Access Road, Dry/Wet Deployment Roads - Shipment of equipment and supplies	\$15 - \$70	\$50 - \$350	\$100 - \$600
Material Cost[2] (Amendment)	- Material cost (including manufacturing)	\$20 - \$40 (PAC) \$50-\$70 (Pellet with weighting agent)	\$100 - \$200 (PAC) \$250-\$350 (Pellet with weighting agent)	\$200 - \$400 (PAC) \$500-\$700 (Pellet with weighting agent)
Implementation	- Equipment Rentals - Labor (amendment deployment and application thickness confirmation measurements)	\$5 - \$15	\$10 - \$40	\$15 - \$75
Demobilization	- Access Road, Dry/Wet Deployment Roads Restoration - Shipment of equipment and supplies	\$15 - \$30	\$40 - \$130	\$70 - \$275
Long-term Monitoring	- Travel and labor (sampling and field surveys) - Shipment of equipment and supplies - Laboratory costs	\$25 - \$50	\$100 - \$150	\$200 - \$250
Reporting	- Annual and 5 year reporting	\$75 - \$100	\$75 - \$100	\$75 - \$100

[1]All costs are in \$1,000s and based on a cost model presented in Final Report: *In Situ* Wetland Restoration Demonstration ESTCP Project No. ER-200825 nd material costs presented in Patmont et al. (2013).

[2]Cost of shipping not included because it will vary with quantity and distance from manufacturer/supplier.

7.1.3 Mobilization and Site Preparation

Typical mobilization costs include the cost for mobilizing construction equipment and temporary facilities and supplies to the site in support of the proposed work activities. In addition, temporary staging areas and access roads may be necessary in the cost estimate in order to mobilize and stage equipment and materials proximal to the proposed treatment areas to facilitate deployment. Unless suitable site features already exist (access roads, cleared lots, etc.), these laydown areas may need to be installed as part of site preparation activities. In order to install these features, limited clearing and grubbing activities may be required. Depending on the condition of the subgrade and potential permit requirements, geosynthetics (geotextiles and/or geogrids) and a 12 to 18 inch deep layer of structural fill (e.g., processed gravel) may be required to provide adequate bearing capacity to support the anticipated construction equipment. Where possible, access roads and staging areas should be constructed in upland areas; however, depending on the wetland configuration and extent of proposed amendment application, temporary access roads may need to be constructed in wetland areas (within the proposed treatment area). Swamp mats may be used if equipment access to the wetland areas is required. Access roads typically need to be a minimum of 15 feet wide, but may need to be wider for specialized equipment such as a Tele-belt (30 feet wide minimum).

For the purpose of the cost analysis presented in this Final Report, mobilization costs may include the following components:

- **Site Access Road and Staging Area** – If necessary, minimal clearing/grubbing and grading may be required to allow for installation of a site access road and staging area. If no access roads need to be constructed, then the cost of materials for the assumed road dimensions could be avoided.
- **Amendment Deployment Road Construction** – If necessary (e.g. Scenario 1), limited clearing/grubbing, and grading may be required to allow for installation of the deployment road.
- **Wetland Access Road Construction** – If necessary (e.g. Scenario 2), swamp mats may be used to establish access in such a way as to optimize efficiency, and ideally clearing/grubbing and grading would be avoided or minimized.

The cost estimate for mobilization using typical conditions ranges from $37,000/ha to $175,000/ha ($15,000/acre to $70,000/acre) and decreases per unit area as the size of the area being treated increases.

7.1.4 Material Cost

A variety of treatment products and dosing rates are possible but an application treatment of pelletized AC to an average dose of 3% by mass in the top 10 to 15 cm of the BAZ is anticipated to be typical for most wetland hydric soils. A variety of commercially available pelletized AC and PAC slurry products should be considered to provide a range of potential costs for a design goal of 3% AC in the top 15 cm of the BAZ (e.g., Figure 7-1). Cost estimates for a soil cover system consisting of a natural organic carbon containing topsoil and sand mixture may also need to be included for a baseline comparison.

Other amendment products are available and can be customized to site-specific needs but are expected to fall within the range of treatment costs provided here. Using a bulk AC cost of about $2.20 US Dollars (USD) per kilogram, Ghosh et al. (2013) provide a cost estimate of about $75,000 per ha ($30,400 per acre). This is consistent with material cost estimates presented by Patmont et al. (2013), who estimated material costs at $49,400/ha ($20,000/acre) to $98,800/ha ($40,000/acre).

Figure 7-1 Pelletized Carbon as SediMite™

7.1.5 Implementation

The size, location and access to the treatment area will often dictate the type of equipment and labor effort required for deployment of the preferred amendment, which thereby influences cost and schedule considerations. Typical equipment described in Section 5 can be used to deploy particulate amendment, and/or a soil cover system. For the application of PAC slurry, a hydroseeder is a viable and cost effective option. The following equipment limitations and production rates may be used as a basis for costing:

- **Bark Blower** – Assume a maximum extent of deployment from the unit is 50 feet and that the unit can deploy material at a rate of two tons per hour, which will vary in the field if the equipment needs to be moved frequently. To account for repositioning of the equipment, it may be assumed up to 12 tons can be deployed per day utilizing this piece of equipment. Because of potential issues with equipment reach and deployment rates utilizing longer hoses, this method may not be cost effective for larger applications and/or applications that require long reach from access roads.
- **Stoneslinger –** Assume a recommend extent of deployment (i.e. reach) is up to 80 feet from the truck at rate of 40 tons per hour; therefore, when factoring in loading and repositioning up to 240 tons can be deployed per day.
- **Tele-belt –** Assume an extent of deployment up to approximately 150 feet from the truck. The operator needs to keep tight control of the boom position and conveyor belt rate since this piece of equipment has the capacity to deployed material at a rate of 250 tons per hour. In order to allow for even placement of the material, the deployment rate should be managed at a rate of approximately 150 tons per hour; therefore, when factoring in loading and repositioning, assume that up to 900 tons per day can be deployed using this piece of equipment.
- **Hydroseeder–** Assume that a mixture of water and PAC (at a mixing ratio of 35-40% carbon by weight), can be applied at a rate of approximately 5 acres per day up to 500 feet from the unit. Hydroseeders with capacities of 600, 1,000, and 4,000 gallons are readily available in most regions of the country.

Even with the potential array of deployment methods that are possible, production rates, and site logistical challenges, the cost of implementation is not likely to be a cost driver compared to other

factors (e.g. material costs, mobilization/demobilization). Typical implementation costs presented in Table 7-1 suggest that the cost of this element may be ½ to ¼ the cost per unit area of other project elements. In fact, the costs of implementation also may decrease significantly as the size of the treatment area increases. Cost estimates reported by Patmont et al. (2013) for placing AC treatment products are similar in magnitude when mobilization/demobilization are considered and ranges from $74,000/ha ($30,000/acre) to $173,000/ha ($70,000/acre). Patmont et al. (2013) note that mechanical mixing of a treatment technology into soil or sediment may cost upwards of $100,000/ha (about $40,000/acre).

7.1.6 Demobilization

Typical costs encountered during demobilization related activities involve shipment of equipment and excess supplies from the site, as well as the removal/restoration of the areas impacted during the deployment process, including the site access roads, deployment roads, and the equipment storage/staging areas. Demobilization costs may include the following assumptions:

- Access roads and staging areas are removed and shipped off-site as "clean fill". Therefore, the cost estimated includes the removal and shipping of the process gravel only (i.e. no disposal costs).
- The removal/disposal of the geosynthetics (geotextiles and/or geogrids) can be disposed as general debris in an appropriately sized roll-off dumpster with cover and associated delivery/pickup and disposal fees.
- Removal and decontamination of the swamp mats, the decontamination pad, the waste profile laboratory, and disposal costs at a properly licensed facility are costs typically encountered.
- Restoration costs (seeding and plantings) for a limited area of wetlands that may be disturbed to provide access for amendment deployment should be anticipated, as appropriate.

7.1.7 Long-Term Monitoring and Reporting

Because this technology involves the *in situ* sequestration of COCs, long-term monitoring activities are likely to be necessary to demonstrate remedial success. Also, because this technology has a limited case study history, specific long-term monitoring requirements have the potential to vary significantly from site to site and may depend on regulatory oversight conditions. Lastly, because of the anticipated potential duration of long-term monitoring and reporting requirements (10 to 20 years), this is a significant component of the overall cost of this technology.

Long-term monitoring activities can typically be assumed to include periodic sampling and evaluation tasks performed during the growing season following amendment deployment, and will often involve sampling of hydric soil, pore water, and possibly tissue samples in the treated area. Monitoring events may potentially consist of activities such as collecting:

1. Pore water concentrations from hydric soil grab samples or passive samplers;
2. Bulk hydric soil concentrations from grab samples;

3. Benthic receptor tissue concentrations from organisms exposed to hydric soils under laboratory conditions (e.g., bioaccumulation assays),
4. Field collection of organisms for tissue residue analysis,
5. Laboratory toxicity testing, and/or
6. Ecological sampling.

For the purposes of preparing a cost estimate, the following typical elements may be considered for a monitoring program:

- Monitoring includes sampling at routine intervals over a 10 to 20 year period. This duration is provided as an example of potential long term monitoring durations.
- A pre-treatment baseline "Time 0" sampling event is included.
- Analyses may be tailored to reflect the data quality objectives so that routine sampling events may vary by frequency. For example, the 10 and 20 year post application events (if applicable) may include the full suite of analysis (bulk soil, pore water, and tissue) in order to gauge the long term effectiveness in reducing the bioavailability of the contaminants. Annual sampling may consist only of ecological field surveys as the treatment products described in this report do not decrease total concentration of contaminants in bulk soil (Ghosh et al., 2013), but monitoring programs will vary, depending on what the regulatory agencies deem appropriate.

As the size of the candidate site is scaled up (e.g., 5 acres, 10 acres, etc.), the costs for long term monitoring may increase, depending upon the degree of characterization desired. Cost estimates for long term monitoring reportedly range from $25,000/ha ($10,000/acre) to ~$125,000/ha ($50,000/acre), depending upon whether sampling for treatability studies and baseline characterization activities are included (Patmont et al., 2013).

Reporting costs are assumed to include a typical brief summary report for each monitoring effort; a comprehensive report is required at the conclusion of the long term monitoring period. Thus, reporting costs may be assumed to be the same regardless of treatment area.

7.2 COST DRIVERS

As depicted in Tables 7-1 and 7-2, the primary cost drivers are mobilization/site preparation, amendment materials, demobilization/site restoration and long-term monitoring costs.

- Mobilization and demobilization costs become less significant to the overall project costs as the application area increases.
- Site preparation/site restoration costs are dictated by providing sufficient access for the construction equipment to effectively deploy amendment. The typical deployment equipment (telebelt, hydroseeder and stoneslinger) require stable access roads to maximize their effective reach for deployment. Depending on the configuration/layout of the wetland and other site specific conditions (type of vegetation, depth of water,

bearing capacity of wetland soils, etc.), access road construction, decommissioning and restoration can make up over half or more of the overall cost.

The type and quantity of amendment required can be a cost driver. For the deployment scenarios identified in the example cost model above, the amendment cost was ~5 to 12% (1 acre vs. 10 acres) of the total construction cost.

Monitoring costs can be substantial. For the immediately foreseeable future, it is likely that extensive monitoring will be required by regulatory stakeholders, given the evolving nature of these technologies. The long-term efficacy of activated carbon treatments is not known. Therefore, monitoring for the sorption capacity of the amendment will be necessary; if the sequestration rate decreases, then reapplication of the amendment may be required. It is anticipated that, over time, less extensive monitoring will be required, once *in situ* technologies become more mainstream components of wetland remedial planning.

7.3 COST ANALYSIS

As previously stated, conventional wetland remedial technologies typically include source removal and restoration. The cost for this traditional approach can range anywhere from an estimated $1.5 million to $2 million per acre depending on the size and type of wetland and depth and type of impacts. Factors which complicate this traditional approach include site access, unstable soil/sediment management, water management and the efficacy of restoration activities. Irrespective of cost, the success of restoration activities can be challenging at best, despite prudent efforts.

Life-cycle costs for the deployment methodologies described herein were calculated using Net Present Value (NPV) of future costs assuming a 20 year remediation timeframe. Long-term monitoring costs are discounted at a rate of 1.7% based on the real discount rate provided by the U.S. Executive Office of the President Office of Management and Budget (Office of Management and Budget, 2012). The total NPV cost for the deployment methodologies described above is projected to range from 200K to 1.2 million (1 acre vs. 10 acres). As such, the projected savings employing these methodologies versus traditional methodologies ranges from 20 to 60%.

8.0 IMPLEMENTATION ISSUES

8.1 REGULATORY CONSIDERATIONS

This section addresses federal requirements for working in and around wetland systems. Regulations that may apply to or permits required for using this *in situ* technology in floodplains and wetlands may vary by state and local authority; thus, the review of regulations and permits provided below is limited to the federal level, but the technology end-user should be aware of local and state requirements. The site-specific contaminants of concern and the regulatory auspice(s) under which the remediation is being conducted may also have specific programmatic requirements not addressed by this regulatory review.

Relevant federal regulatory drivers include the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), which authorizes USEPA to clean up contaminated sites and to compel responsible parties to perform cleanups or reimburse the government for USEPA-lead cleanups, as well as others described herein.

Other pertinent federal regulations include:

- **CWA Sections 404 and 401** establish performance standards and water quality standards for the discharge of dredged or fill material into U.S. waters that may impact habitat and adversely affect the biological productivity of wetlands/aquatic ecosystems by smothering, by dewatering, by permanently flooding, or by altering substrate elevation or periodicity of water movement.
- **Endangered Species Act (16 United States Code [USC] Chapter 35)** requires determination as to whether such species and its habitat reside within an area where an activity under review by a governmental authority may take place. The technology should be evaluated in this context if such species or habitats are present, as with any technology.
- The **Migratory Bird Treaty Act (Title 16 USC Sections 703-712)** protects migratory birds, their eggs, and nests from actions that may kill or disturb them. Use of *in situ* remedial technologies may have the potential for accidental death or injury of migratory birds during construction activities, depending on seasonality, site-specific habitat, construction approach (schedule aggressiveness, extent of laydown areas, clearing and grubbing activities, ingestion, etc). The presence of migratory birds should be determined prior to construction and mitigated against.
- **Floodplain development** under Executive Order 11988 and the protection of wetlands under Executive Order 11990 require actions to avoid or minimize long- and short-term adverse impacts associated with the occupancy and modification of floodplains and the destruction or modification of wetlands, respectively. Manual and automated methods of material deployment are typically used to minimize impact to wetland soils and vegetation. A well thought out construction approach and one that incorporates project scale-appropriate contingency plans for unforeseen conditions will reduce the potential for causing adverse impacts. These Executive Orders are typically "to be considered," (TBC) rather than ARARs.

- **Fish and Wildlife Coordination Act** (16 USC Chapter 5A) requires that any modification of any stream affected by an authorized action provide adequate protection of fish and wildlife resources.
- **Coastal Zone Management Act** (16 USC Section 145) requires that activities affecting the coastal zone and adjacent shoreline are conducted in manner that is consistent with approved State management programs.
- **Federal or state water quality standards or relevant and appropriate requirements (ARARs)** may be applicable for determining cleanup levels. Water quality standards may be relevant and appropriate depending on the uses designated by the state, which are based on existing and attainable uses. As described in *Water Quality Standards for Wetlands National Guidance (*USEPA, 1990b), state water quality criteria may contain narrative criteria that prohibit certain actions or conditions or statements about what is expected (e.g., "aquatic life shall be as it naturally occurs").
- In addition, the federal government is actively pursuing a sustainable approach to all its activities in accordance with Executive Orders 13423 (2007) and 13514 (2009), and the recent DON (2012a, b) and DoD (2008) guidances. Less invasive *in situ* technologies may be more often considered when sustainability metrics are included in remedial decisions.

Numerous additional TBC regulations are summarized in *CERCLA Compliance With Other Laws Manual* (USEPA, 1988). Depending on site specific needs, some TBC regulations may be ARARs (e.g. NPDES discharge, RCRA solid waste management).

Several guidance documents provide overarching wetlands and sediment remediation guidance and information on topics closely related to *in situ* active remediation technologies. These include but are not limited to:

- *Considering Wetlands at CERCLA Sites* (USEPA 1994c),
- *Water Quality Standards for Wetlands National Guidance* (USEPA, 1990b),
- *Contaminated Sediment Remediation Guidance for Hazardous Waste Sites* (USEPA, 2005),
- *Green Remediation: Incorporating Sustainable Environmental Practices into Remediation of Contaminated Sites* (USEPA, 2008b),
- *Incorporating Bioavailability Considerations into the Evaluation of Contaminated Sediment Sites* (ITRC, 2011),
- *Guidance on Green and Sustainable Remediation* (DON, 2012),
- *Consideration of GSR practices in the Defense Environmental Restoration Program* (DoD 2009),
- *Sediment Capping Resource for Manufactured Gas Plant Sites* (Palermo et al., 2008), and
- *User's Guide for Assessing Sediment Transport at Navy Facilities* (DON, 2007).

8.2 LESSONS LEARNED AND RECOMMENDATIONS

The PCB bioavailability analysis determined that the solid phase partitioning was enhanced and bioavailability was reduced by addition of carbon amendments to the Canal Creek wetland system. This result was more apparent in the partitioning evaluations than in the direct measurements of pore water concentration reductions, due to a large heterogeneity in PCB distribution, small sample size, and sampling/analysis artifacts. A treatment design of 5% AC is consistent with the results reported in the Treatability Study (NAVFAC ESC, 2009d). However, the results of the demonstration due highlight the challenges of moving a treatment from a controlled environment to uncontrolled environmental conditions. In addition to uncontrolled environmental conditions, the performance monitoring schema may require adaptive modification if ambiguous results are obtained within the first monitoring event or two. Longer term monitoring periods are needed to address such issues and to evaluate the long term permanence of the treatment. The results of the ecological monitoring suggest that there was no effect of treatment on plant species composition, diversity, or abundance within the field demonstration wetland. However, longer term monitoring is recommended to provide a more rigorous assessment. Furthermore, none of the demonstration treatments are likely to impair the uptake of nutrients and metals into plants in treated wetlands. The limited number of benthic organisms in the wetlands prohibited a robust evaluation of treatment effects on this community.

Some hypotheses as to why AquaBlok® showed statistically significant increases in partitioning relative to the other amendment delivery systems are:

- Perhaps significant to the apparent lack of reduction in pore water bioavailability is a general increase in bulk soil PCBs with each sampling event;
- The PAC Slurry Spray treatment is expected to have released AC to the soil immediately but until mixing processes can incorporate AC into the soil, the AC is susceptible to migration in the environment (e.g. wind or water induced migration) as opposed to the slower release from the pelletized delivery systems. Slurry PAC may have migrated prior to being fully mixed into the soil at some locations;
- Based on visual observations of Time 2 cores, the presence of AC was apparent in cores collected from AquaBlok® treatment plots, suggesting that the rate of AC release from the delivery agent may be an important variable to explain the demonstration results. AC had clearly desorbed from the AquaBlok® aggregate and visible migration downward through the soil profile in pore spaces (primary and secondary) and along roots was noticeable in most cores;
- The timing and mechanisms of AC release from the other pelletized delivery system, SediMite™, is similar to that of the PAC slurry in that the binding agent is expected to break down rapidly, releasing the AC soon after application. Conditions more conducive to breakdown or mixing than those encountered in the study area test plots (e.g. degree saturation or greater interaction with benthos) may have been lacking to effectively mix the SediMite™. Root mixing, which may be the primary mixing mechanism at the site, may not be an effective means of incorporating SediMite™ into the soil;

- The source of organic carbon in the Sand control cover was natural organic carbon and not black carbon, which is more effective at sorbing HOCs. Also, there is visual observation evidence that the Sand control may form a physical barrier that inhibits mixing processes in the BAZ;

- The observed average increase in partitioning for Control plots raises questions about monitoring design because it is not readily apparent what may be the root cause of this result. Migration of black carbon is one potential cause but an evaluation of black carbon is unable to fully account for this result;

- Composite sampling and field homogenization of sediment samples may have artificially over-incorporated PCBs relative to the achieved treatment depth for the given treatment period. Incremental sampling with depth and longer term monitoring could have potentially elucidated this effect; and

- Lastly, pooling Time 1 and Time 2 populations for the statistical comparison to Time 0 results may also underestimate the role that time has on the efficacy of the different treatment types.

Use of the technologies evaluated in this demonstration project is cost-effective but challenges in technology delivery were noted during cold weather. The technology is best suited for application to:

- Contaminated hydric soils located in beneficial habitats such as wetlands, where habitat disruption should be minimized;

- Contaminated hydric soils located where desirable wildlife might be harmed by traditional remedial methods, such as dredging;

- Contaminated hydric soils pose an unacceptable risk, but the level of risk is not sufficient to justify the cost of excavation or dredging, disposal, and restoration;

- Sites where access to the wetland system (e.g., infrastructure improvements) to deliver sequestration agents is not cost-prohibitive; and

- Sites where long-term monitoring requirements are not cost-prohibitive (such that removal might merit consideration).

Points of contact for additional information regarding the *In Situ* Wetland Restoration Demonstration (ESTCP Project Number ER-200825) are provided in Appendix I.

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Appendix A: Photographic Log

AECOM

PHOTOGRAPHIC LOG

Project Name: *In Situ* Wetland Restoration Demonstration	Site Location: Canal Creek, Aberdeen Proving Ground	Project No. ESTCP Project Number ER-0825

Photo No.	Date:
1	12/08/10

Description:
West Branch Canal Creek wetlands study area during low tide.

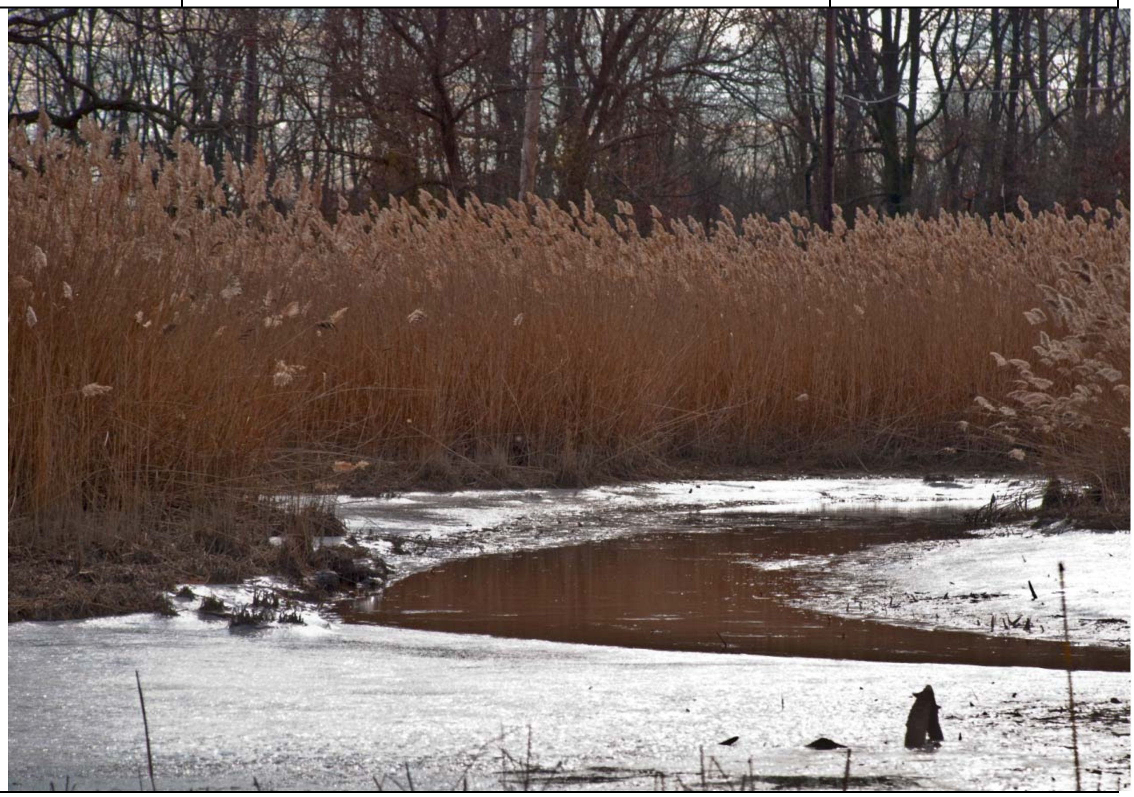


Photo No.	Date:
2	12/08/10

Description:
Foot path access to test plots.

AECOM

PHOTOGRAPHIC LOG

Project Name: *In Situ* **Wetland Restoration Demonstration**	**Site Location:** Canal Creek, Aberdeen Proving Ground	**Project No.** ESTCP Project Number ER-0825

Photo No. 3	**Date:** 12/03/10

Description:
Flagging and staking UXO cleared test plots.

Photo No. 4	**Date:** 12/03/10

Description:
Flagging and staking UXO cleared test plots.

PHOTOGRAPHIC LOG		
Project Name: *In Situ* **Wetland Restoration Demonstration**	**Site Location:** Canal Creek, Aberdeen Proving Ground	**Project No.** ESTCP Project Number ER-0825

Photo No. 5	**Date:** 12/03/10
Description: Straw wattles stacked in project staging area.	

Photo No. 6	**Date:** 12/03/10
Description: Test plot preparation.	

PHOTOGRAPHIC LOG

Project Name:
***In Situ* Wetland Restoration Demonstration**

Site Location:
Canal Creek, Aberdeen Proving Ground

Project No.
ESTCP Project Number ER-0825

Photo No. 7

Date: 12/03/10

Description:
Bulk sediment samples were collected with a stainless steel soil auger, homogenized, and composited.

Photo No. 8

Date: 12/03/10

Description:
Field processing of baseline characterization hydric soil samples.

PHOTOGRAPHIC LOG

Project Name: *In Situ* Wetland Restoration Demonstration	**Site Location:** Canal Creek, Aberdeen Proving Ground	**Project No.** ESTCP Project Number ER-0825

Photo No. 9	**Date:** 12/08/10

Description:
Loading AC into Vortex Spreader.

Photo No. 10	**Date:** 12/08/10

Description:
AquaBlok was delivered in 1.25 ton super-sacks on pallets and a forklift was used to lift the super-sacks above the receiving hopper of the bark-blower.

AECOM

PHOTOGRAPHIC LOG

Project Name: *In Situ* Wetland Restoration Demonstration	Site Location: Canal Creek, Aberdeen Proving Ground	Project No. ESTCP Project Number ER-0825

Photo No.	Date:
11	12/08/10

Description:
Cleared test plot rimmed by straw wattles secured by stakes.

Photo No.	Date:
12	12/08/10

Description:
Delivery of pelletized activated carbon to a test plot.

AECOM

PHOTOGRAPHIC LOG

Project Name: *In Situ* Wetland Restoration Demonstration	Site Location: Canal Creek, Aberdeen Proving Ground	Project No. ESTCP Project Number ER-0825

Photo No. 13	Date: 12/08/10

Description:
Delivery of activated carbon slurry to a test plot.

Photo No. 14	Date: 12/08/10

Description:
Close-up view of hose and nozzle used to deliver activated carbon slurry.

PHOTOGRAPHIC LOG

Project Name: *In Situ* Wetland Restoration Demonstration	Site Location: Canal Creek, Aberdeen Proving Ground	Project No. ESTCP Project Number ER-0825

Photo No.	Date:
15	12/08/10

Description:
Test plot covered with activated carbon slurry.

Photo No.	Date:
16	12/08/10

Description:
Test plots adjacent to Canal Creek at high tide. Plots are separated by straw wattles to isolate treatment areas.

AECOM

PHOTOGRAPHIC LOG

Project Name: *In Situ* Wetland Restoration Demonstration	Site Location: Canal Creek, Aberdeen Proving Ground	Project No. ESTCP Project Number ER-0825

Photo No.	Date:
17	12/08/10

Description:
Foot paths to test plots. Thin ice covers portions of the wetlands.

Photo No.	Date:
18	12/08/10

Description:
Test plot after treatment deployment.

AECOM

PHOTOGRAPHIC LOG

Project Name: *In Situ* Wetland Restoration Demonstration	Site Location: Canal Creek, Aberdeen Proving Ground	Project No. ESTCP Project Number ER-0825

Photo No. 19 **Date:** 12/08/10

Description:
Areas receiving UXO clearance were delineated by high visibility flagging tape as part of the project's health and safety plan.

Photo No. 20 **Date:** 12/08/10

Description:
Hydroseeder equipment used to deploy activated carbon slurry.

PHOTOGRAPHIC LOG

Project Name: *In Situ* Wetland Restoration Demonstration	Site Location: Canal Creek, Aberdeen Proving Ground	Project No. ESTCP Project Number ER-0825

Photo No.	Date:
21	12/08/10

Description:
Decontamination station in upland laydown area.

Photo No.	Date:
22	12/08/10

Description:
Manual sand application methods were used when low air temperatures froze the wet sand mixture.

AECOM

PHOTOGRAPHIC LOG

Project Name: *In Situ* **Wetland Restoration Demonstration**	**Site Location:** Canal Creek, Aberdeen Proving Ground	**Project No.** ESTCP Project Number ER-0825

Photo No.	**Date:**
23	12/08/10

Description:
Sand delivery via a bark blower and a 4-inch hose.

Photo No.	**Date:**
24	12/08/10

Description:
Sand delivery via a bark blower and a 4-inch hose.

AECOM

PHOTOGRAPHIC LOG		
Project Name: *In Situ* **Wetland Restoration Demonstration**	**Site Location:** Canal Creek, Aberdeen Proving Ground	**Project No.** ESTCP Project Number ER-0825

Photo No. 25	**Date:** 12/08/10
Description: Pelletized activated carbon.	

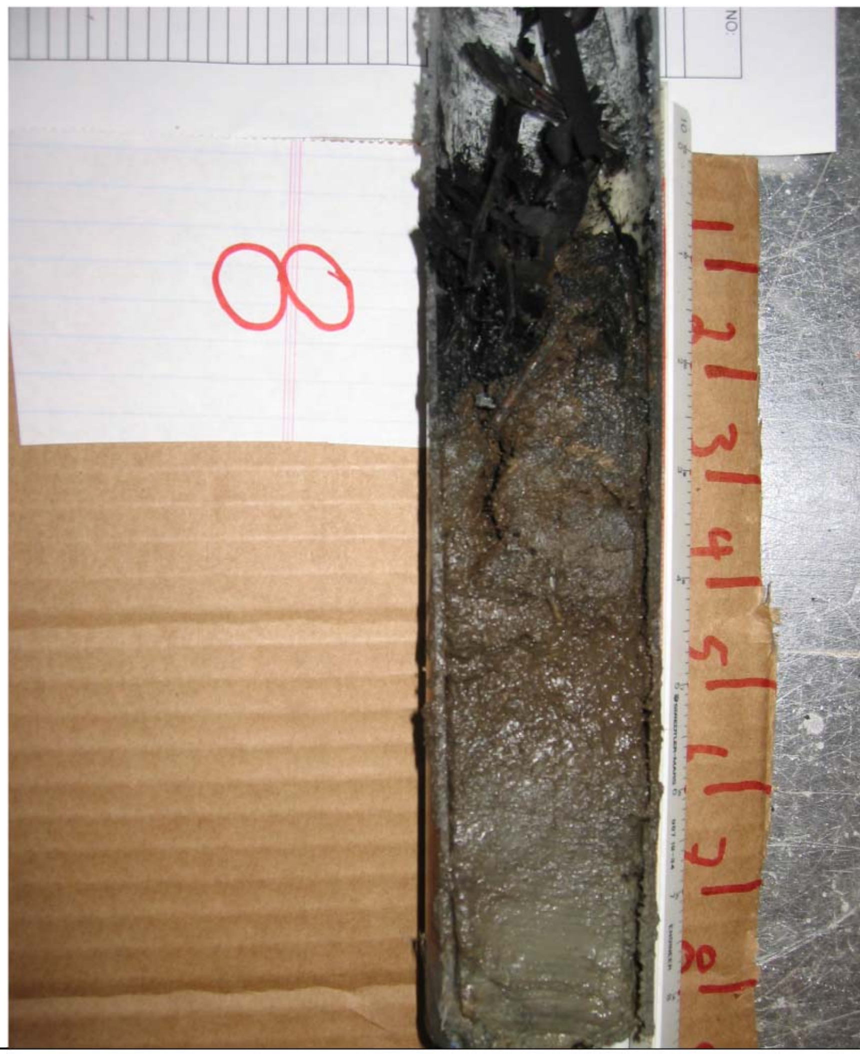
Photo No. 26	**Date:** 12/08/10
Description: Sand mixture application using bark blower and 2-inch hose.	

PHOTOGRAPHIC LOG		
Project Name: **ESTP Canal Creek Field Demonstration**	**Site Location:** Canal Creek, Aberdeen Proving Ground	**Project No.** 60133180

Photo No.	**Date:**
27	12/10/10

Description:
T0 core with AC Slurry treatment at APG-08. Activated carbon appears to have reached about 3 inches depth.

Activated carbon with loose bark mulch/organic mix; soft, gray mottled with light brown silt mixed with overlying mulch; soft, brown silt, roots and organics; gray silt.



AECOM

PHOTOGRAPHIC LOG		
Project Name: **ESTP Canal Creek Field Demonstration**	**Site Location:** Canal Creek, Aberdeen Proving Ground	**Project No.** 60133180

Photo No. 28	**Date:** 12/10/10

Description:
T0 core with SediMite™ treatment at APG-17. Activated carbon appears to have reached about 4 inches depth.

Activated carbon and trace organics; root fragments transition to reddish brown silt; soft, gray to dark gray silt with roots throughout.

PHOTOGRAPHIC LOG		
Project Name: **ESTP Canal Creek Field Demonstration**	**Site Location:** Canal Creek, Aberdeen Proving Ground	**Project No.** 60133180

Photo No. 29	**Date:** 12/10/10

Description:
T0 core with AquaBlok® treatment at APG-20. Activated carbon appears to have reached 3 to 4 inches depth along roots. A delivery system pellet appears to have settled to 8 to 9 inches depth.

Black carbon and light reddish brown silt mixed with organics and AquaBlok® aggregate. Soft, grayish brown silt with roots; root mass to depth with organics.

PHOTOGRAPHIC LOG

Project Name:
ESTP Canal Creek Field Demonstration

Site Location:
Canal Creek, Aberdeen Proving Ground

Project No.
60133180

Photo No.
30

Date:
12/10/10

Description:
T0 core with Sand/soil cover at APG-10. Sand/soil cover to 2 inches depth.

Gray, fine-medium sand; very dark grayish brown soft silt; gray clay; soft very dark grayish brown silt with root material.

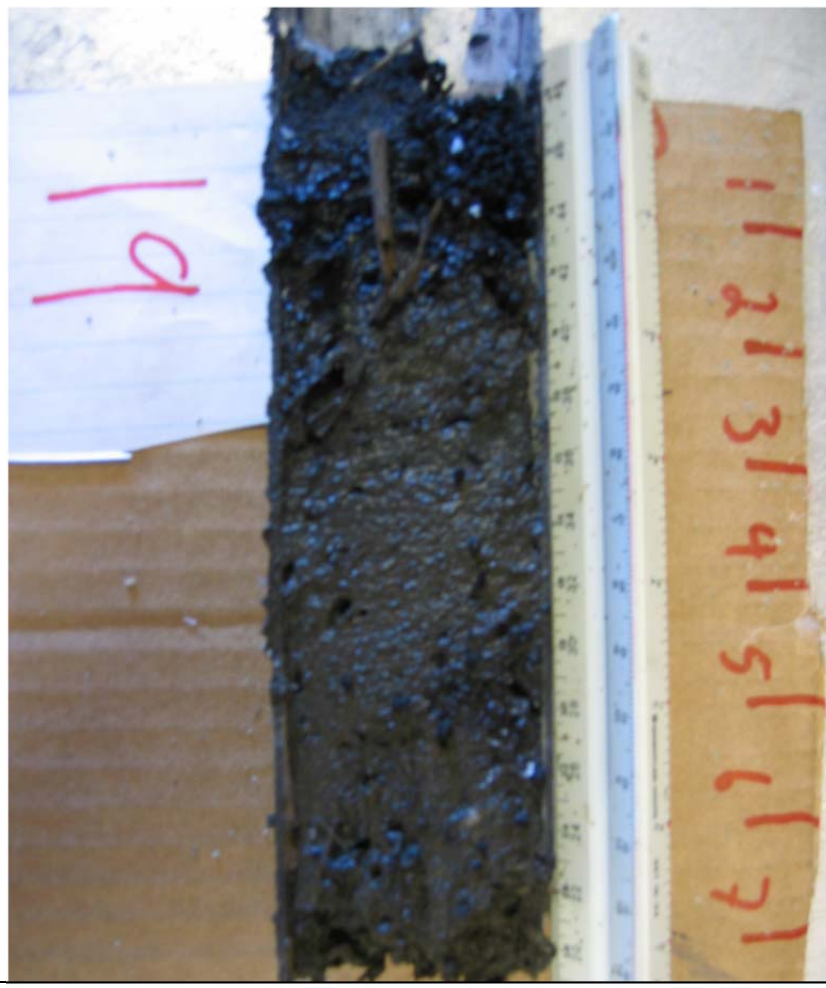
AECOM

PHOTOGRAPHIC LOG		
Project Name: **ESTCP Canal Creek Field Demonstration**	**Site Location:** Canal Creek, Aberdeen Proving Ground	**Project No.** 60133181

Photo No. 31	**Date:** 12/10/10

Description:
T0 core with SediMite™ treatment at APG-19. Activated carbon appears to have reached 2 to 3 inches depth.

Black carbon and trace organics; transition zone carbon/soft grayish brown silt; Soft grayish brown silt root material/organics.

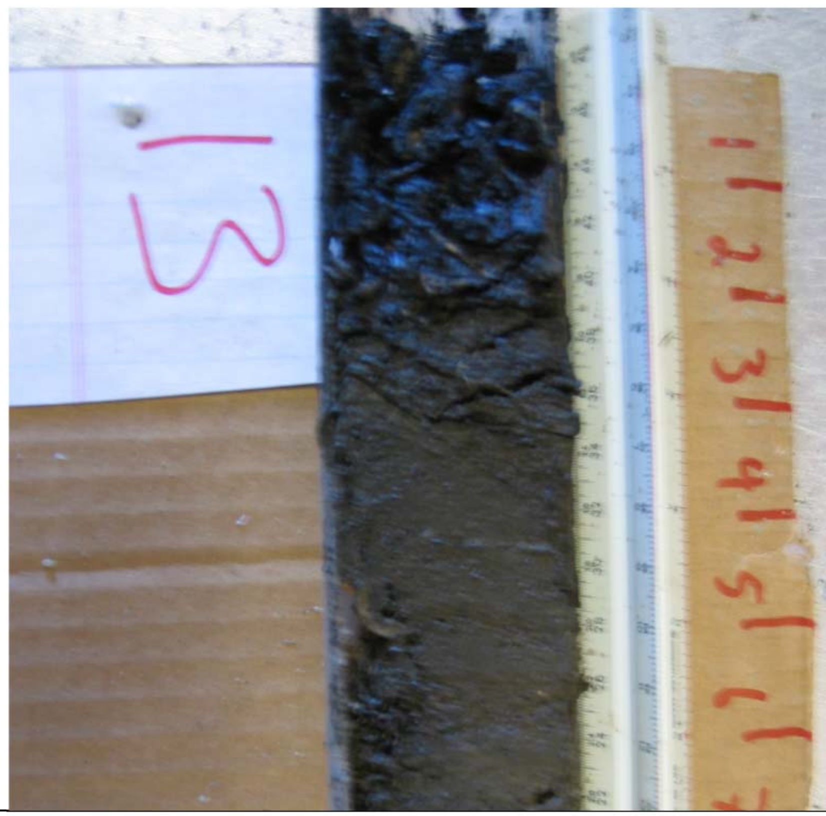


AECOM

PHOTOGRAPHIC LOG			
Project Name: **ESTCP Canal Creek Field Demonstration**		**Site Location:** Canal Creek, Aberdeen Proving Ground	**Project No.** 60133181
Photo No. 32	**Date:** 12/10/10		

Description:
T0 core with AquaBlok® treatment at APG-13. Activated carbon appears to have reached 2 to 3 inches depth.

Small aggregate and black carbon mixed with black silt; soft brown silt with roots material and organics.



PHOTOGRAPHIC LOG

Project Name: ESTCP Canal Creek Field Demonstration	**Site Location:** Canal Creek, Aberdeen Proving Ground	**Project No.** 60133181

Photo No. 33	**Date:** 12/10/10

Description:
T0 core with Sand/soil cover at APG-14.

Light gray fine-medium sand; transition zone, sand/roots; soft, grayish brown silt; roots at depth.

PHOTOGRAPHIC LOG

Project Name: ESTCP Canal Creek Field Demonstration	Site Location: Canal Creek, Aberdeen Proving Ground	Project No. 60133181

Photo No.	Date:
34	12/10/10

Description:
T0 core with AC Slurry treatment at APG-02. Activated carbon appears to have reached 2 inches depth.

Soft, black carbon with organics; transition to very dark brown silt; roots at depth.

PHOTOGRAPHIC LOG

Project Name: ESTCP Canal Creek Field Demonstration	Site Location: Canal Creek, Aberdeen Proving Ground	Project No. 60133181

Photo No.	Date:
35	12/10/10

Description:
T2 core with Sand/soil cover at APG-01. Fresh deposition above the sand.

Dark brown, organic silt over 2 inches of grayish brown sand/soil cover, dark brown sandy silt with roots.

AECOM

PHOTOGRAPHIC LOG		
Project Name: **ESTCP Canal Creek Field Demonstration**	**Site Location:** Canal Creek, Aberdeen Proving Ground	**Project No.** 60133181

Photo No. 36	**Date:** 12/10/10

Description:
T2 core with AquaBlok® treatment at APG-06. Fresh deposition appears to have buried AquaBlok®, which appears at 2 to 3 inches depth, with AC mixed to about 4 inches depth.

Fresh deposit of pale brown clay over 1 inch AquaBlok® aggregate and silt, black carbon and silt, yellowish brown silt and roots with some black carbon.

PHOTOGRAPHIC LOG

Project Name: ESTCP Canal Creek Field Demonstration	Site Location: Canal Creek, Aberdeen Proving Ground	Project No. 60133181

Photo No.	Date:
37	12/10/10

Description:
T2 core at APG-07, a Control plot.

Grayish brown silt with root material and organics, red staining of very pale brown silt with and roots.

PHOTOGRAPHIC LOG

Project Name: ESTCP Canal Creek Field Demonstration	Site Location: Canal Creek, Aberdeen Proving Ground	Project No. 60133181

Photo No.	Date:
38	12/10/10

Description:
T2 core with AC Slurry treatment at APG-08. AC appears mixed to approximately 1 inch depth.

Dark brown organic silt over 1 inch thick reddish iron oxide coating; soft brown silt with roots and very dark brown mottles.

PHOTOGRAPHIC LOG		
Project Name: **ESTCP Canal Creek Field Demonstration**	**Site Location:** Canal Creek, Aberdeen Proving Ground	**Project No.** 60133181

Photo No. 39	**Date:** 12/10/10	
Description: T2 core with AquaBlok® treatment at APG-09. AC appears to have mixed to 3 to 4 inches depth. Dark brown silt and organics, 1 inch thick reddish iron oxide coating, dark brown, organic silt with roots, yellowish brown, some roots.		

PHOTOGRAPHIC LOG				
Project Name: **ESTCP Canal Creek Field Demonstration**		**Site Location:** Canal Creek, Aberdeen Proving Ground		**Project No.** 60133181
Photo No. 40	**Date:** 12/10/10			
Description: T2 core with Sand/soil cover at APG-10. Grayish brown to dark grayish brown fine sand and silt with roots.				

PHOTOGRAPHIC LOG

Project Name: ESTCP Canal Creek Field Demonstration	Site Location: Canal Creek, Aberdeen Proving Ground	Project No. 60133181

Photo No.	Date:
41	12/10/10

Description:
T2 core at APG-12, a control plot.

Yellowish brown organic silt with red iron oxide staining over grayish brown silt with roots. Sheen observed throughout.

AECOM

PHOTOGRAPHIC LOG

Project Name: ESTCP Canal Creek Field Demonstration	Site Location: Canal Creek, Aberdeen Proving Ground	Project No. 60133181

Photo No.	Date:
42	12/10/10

Description:
T2 core with AquaBlok® treatment at APG-13. AC appears well mixed to 2 to 3 inches depth with infiltration to bottom of core along rhizome macropores.

Black silt with aggregate, grayish brown fine sand to silt with black carbon and roots, grayish brown fine sand with carbon staining along roots and red iron oxide coating, gray mottled with yellowish brown fine sand and silt.

AECOM

PHOTOGRAPHIC LOG

Project Name: ESTCP Canal Creek Field Demonstration	Site Location: Canal Creek, Aberdeen Proving Ground	Project No. 60133181

Photo No.	Date:
43	12/10/10

Description:
T2 core with Sand/soil cover at APG-14.

Very dark grayish brown, fine to medium sand with organics; very pale brown clay with red iron oxide coating;
dark brown, organic silt and roots.

PHOTOGRAPHIC LOG

Project Name: ESTCP Canal Creek Field Demonstration	Site Location: Canal Creek, Aberdeen Proving Ground	Project No. 60133181

Photo No. 44	Date: 12/10/10

Description:
T2 core at APG-15, a Control plot.

Brown organic silt with red iron oxide coating and roots throughout.

Photo No. 45	**Date:** 12/10/10	
Description: T2 core with SediMiteTM treatment at APG-16. AC appears to occur down to 3 to 4 inches depth Gray to dark gray fine sand and silt with black organic staining along roots; yellow clay with reddish brown iron oxide coating; gray to dark gray fine sand, roots, reddish brown iron oxide coating.		

PHOTOGRAPHIC LOG		
Project Name: **ESTCP Canal Creek Field Demonstration**	**Site Location:** Canal Creek, Aberdeen Proving Ground	**Project No.** 60133181

Photo No. 46	**Date:** 12/10/10

Description:
T2 core with SediMite™ treatment at APG-17. AC appears to have migrated along macropores to 3 to 4 inches depth.

Very dark grayish brown sandy silt with roots and reddish brown iron oxide coating.

AECOM

PHOTOGRAPHIC LOG

Project Name: ESTCP Canal Creek Field Demonstration	Site Location: Canal Creek, Aberdeen Proving Ground	Project No. 60133181

Photo No.	Date:
47	12/10/10

Description:
T2 core with SediMite™ treatment at APG-18.

Very dark grayish brown mottled with yellowish brown, sandy silt with roots and reddish brown iron oxide coatings around secondary porosity features, roots and organics.

PHOTOGRAPHIC LOG

Project Name: ESTCP Canal Creek Field Demonstration	Site Location: Canal Creek, Aberdeen Proving Ground	Project No. 60133181

Photo No.	Date:
48	12/10/10

Description:
T2 core with SediMite™ treatment at APG-19. AC is readily apparent in macropores throughout the core.

Dark yellowish brown, organic material, dark gray to black; yellow clay with black root penetration and reddish brown iron oxide coating; dark gray silt.

Photo No. 49	**Date:** 12/10/10	
Description: T2 core with AquaBlok® treatment at APG-20. Aggregate mixed to 3 inches depth and AC vertically well mixed to 4 inches depth. AC is visible in macro pores to end of core. Black silt with AquaBlok® aggregate; Black to light gray silt with roots; dark gray silt with roots and organics.		

AECOM

PHOTOGRAPHIC LOG		
Project Name: **ESTCP Canal Creek Field Demonstration**	**Site Location:** Canal Creek, Aberdeen Proving Ground	**Project No.** 60133181

Photo No. 50	**Date:** 12/10/10

Description:
T2 core with AquaBlok® treatment at APG-21. Aggregate visible at 2 inches depth with evidence of AC. AC in macropore at 4 to 5 inches depth.

Very dark brown to black silt with AquaBlok® aggregate; gray to grown silt with roots and reddish brown iron oxide coating in bottom 2 inches of core.

PHOTOGRAPHIC LOG

Project Name: ESTCP Canal Creek Field Demonstration	**Site Location:** Canal Creek, Aberdeen Proving Ground	**Project No.** 60133181

Photo No. 51	**Date:** 12/10/10

Description:
T2 core with AC Slurry treatment at APG-22. AC visible along macropores at approximately 3 inches depth.

Gray with brownish yellow organic silt and roots, some oxidation apparent along roots/secondary porosity features; reddish brown iron oxide coating of dark brown silt.

AECOM

PHOTOGRAPHIC LOG		
Project Name: **ESTCP Canal Creek Field Demonstration**	**Site Location:** Canal Creek, Aberdeen Proving Ground	**Project No.** 60133181

Photo No. 52	**Date:** 12/10/10

Description:
T2 core with AC Slurry treatment at APG-23. AC vertically well mixed in top 2 inches.

Black organic silt, grayish brown silt with roots and organics with yellow and reddish coating.

PHOTOGRAPHIC LOG		
Project Name: **ESTCP Canal Creek Field Demonstration**	**Site Location:** Canal Creek, Aberdeen Proving Ground	**Project No.** 60133181

Photo No. 53	**Date:** 12/10/10	
Description: T2 core with AquaBlok® treatment at APG-24. AC appears to be vertically mixed throughout length of core. Black organic silt with AquaBlok® aggregate (top 2 inches); Black silt with organics.		

Appendix B: PCB Laboratory Data

UNH Technical Laboratory Report

Analytical Analysis for “In Situ Wetland Remediation”
ESCTCP Project: ER-0825

Prepared for:

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January 15, 2013

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1.0 Introduction

Bulk hydric soil, macroinvertebrate receptor tissue and PED passive pore water samples were evaluated by the University of New Hampshire for general environmental characteristics and PCB concentrations as part of an *in situ* wetland remediation field evaluation (ESTCP Project ER-0825: *In Situ* Wetland Restoration Demonstration). General environmental characterizations included determining the moisture content, natural organic carbon content and black carbon content within the hydric soil over three sampling events (1 pre-treatment, 2 post-treatment). PCB concentrations were evaluated within the bulk soil, pore water and receptor tissue phases. This report describes the samples detail, analytical methods and results of these evaluations.

2.0 Sample Details

Bulk hydric soil samples, macroinvertebrate receptor tissue samples and PED pore water samplers collected from the Canal Creek *In Situ* Wetland Remediation Testing Site were evaluated by the University of New Hampshire. Sampling details are provided in the sections below.

2.1 Hydric Soil Samples

Hydric soil samples were collected from APG and shipped to UNH laboratories for three sampling events in December 2010 (Time-0); June 2011 (Time-1) and October 2011 (Time-2). Samples collected for the Time-0 sampling event were received at UNH laboratories on December 7, 2010. All grab samples were provided in 1L, 8oz and 4oz jars from 20 of the 24 treatment plots and 10 dual composite samples. Time-0 samples for plots APG-16, APG-17, APG-18 and APG-19 were collected by ExPonent in November of 2009 and shipped to UNH in 2011. Time-1 samples, included grab samples in 8oz and 1 L jars as well as 6 in cores. Grab samples were collected from all 24 treatment plots and 12 dual plot composite sample. Cores were collected from all 24 treatment plots. Time-1 samples were received at UNH laboratories on June 9, 2011. Time-2 samples also included grab samples in 8oz and 1 L jars as well as 6 in cores. Grab samples were collected from all 24 treatment plots and 12 dual plot composite sample. Cores were collected from all 24 treatment plots. Time 2 samples were all received at UNH labs on October 11, 2011. Sample details are summarized in Table 2.1.

2.2 Macroinvertebrate Tissue Samples

Benthic tissue samples were collected from APG site in gallon hydric soil samples and sent to bioaccumulation labs for 28 day exposure period using Lumbriculus variegatus. The T0 and T1 samples were sent to the AECOM Toxicology Laboratory for analysis and T2 samples were sent to Aquatec Biological Sciences. Time 0 tissue samples were received at UNH laboratories in two shipments on August 23, 2011 and August 30, 2011 in 20 ml vials in triplicates. Time 1 samples were received on October 11, 2011 and October 19, 2011. All Time 2 Samples were recieved on February 8, 2012. T1 samples were sent in 20 ml vials in duplicates. Samples from Time 2 were sent in triplicates in 40 ml vials. A summary of the samples is show in Table 1.2. Samples are listed by their sampling dates.

Table 2.1: Hydric Soil Sample Details

Sample Location	**Sample Dates**		
	December 2010 (Time 0)	**June 2011 (Time 1)**	**October 2011 (Time 2)**
APG-01	1L , 4 oz, 8 oz	8 oz, 1 LG, 6” core	2x6”core, 8 oz, 1 L
APG-02	1L , 4 oz, 8 oz	8 oz, 1 LG, 6” core	6”, 1 L
APG-03	1L , 4 oz, 8 oz	8 oz, 1 LG, 6” core	2x6”core, 8 oz, 1 L
APG-04	1L , 4 oz, 8 oz	8 oz, 1 LG, 6” core	2x6”core, 8 oz, 1 L
APG-04 MS	1L , 4 oz, 8 oz	*Not Sampled*	*Not Sampled*
APG-04 MSD	1L , 4 oz, 8 oz	*Not Sampled*	*Not Sampled*
APG-05	1L , 4 oz, 8 oz	8 oz, 1 LG, 6” core	2x6”core, 8 oz, 1 L
APG-05 Dup	1L , 4 oz, 8 oz	*Not Sampled*	*Not Sampled*
APG-06	1L , 4 oz, 8 oz	8 oz, 1 LG, 6” core	2x6”core, 8 oz, 1 L
APG-07	1L , 4 oz, 8 oz	8 oz, 1 LG, 6” core	2x6”core, 8 oz, 1 L
APG-08	1L , 4 oz, 8 oz	8 oz, 1 LG, 6” core	6”, 1 L
APG-09	1L , 4 oz, 8 oz	8 oz, 1 LG, 6” core	2x6”core, 8 oz, 1 L
APG-10	1L , 4 oz, 8 oz	8 oz, 1 LG, 6” core	2x6”core, 8 oz, 1 L
APG-11	1L , 4 oz, 8 oz	8 oz, 1 LG, 6” core	2x6”core, 8 oz, 1 L
APG-12	1L , 4 oz, 8 oz	8 oz, 1 LG, 6” core	2x6”core, 8 oz, 1 L
APG-13	1L , 4 oz, 8 oz	8 oz, 1 LG, 6” core	2x6”core, 8 oz, 1 L
APG-14	1L , 4 oz, 8 oz	8 oz, 1 LG, 6” core	2x6”core, 8 oz, 1 L
APG-15	1L , 4 oz, 8 oz	8 oz, 1 LG, 6” core	2x6”core, 8 oz, 1 L
APG-16	*1L , 4 oz, 8 oz	8 oz, 1 LG, 6” core	2x6”core, 8 oz, 1 L
APG-17	*1L , 4 oz, 8 oz	8 oz, 1 LG, 6” core	2x6”core, 8 oz, 1 L
APG-18	*1L , 4 oz, 8 oz	8 oz, 1 LG, 6” core	2x6”core, 8 oz, 1 L
APG-19	*1L , 4 oz, 8 oz	8 oz, 1 LG, 6” core	8 oz, 1 L
APG-20	1L , 4 oz, 8 oz	8 oz, 1 LG, 6” core	2x6”core, 8 oz, 1 L
APG-21	1L , 4 oz, 8 oz	8 oz, 1 LG, 6” core	2x6”core, 8 oz, 1 L
APG-22	1L , 4 oz, 8 oz	8 oz, 1 LG, 6” core	2x6”core, 8 oz, 1 L
APG-23	1L , 4 oz, 8 oz	8 oz, 1 LG, 6” core	2x6”core, 8 oz, 1 L
APG-24	1L , 4 oz, 8 oz	8 oz, 1 LG, 6” core	2x6”core, 8 oz, 1 L
APG-11/13	1L , 8 oz	8 oz	8 oz
APG-14/10	1L , 8 oz	8 oz	8 oz
APG-12/20	1L , 8 oz	8 oz	8 oz
APG-15/21	1L , 8 oz	8 oz	8 oz
APG-06/24	1L , 8 oz	8 oz	8 oz
APG-02/08	1L , 8 oz	8 oz	8 oz
APG-05/09	1L , 8 oz	8 oz	8 oz
APG-04/07	1L , 8 oz	8 oz	8 oz
APG-22/23	1L , 8 oz	8 oz	8 oz
APG-01/03	1L , 8 oz	8 oz	8 oz
APG-MS/MSD	*Not Sampled*	1 L	1 L
Blank	1 L	1 L	1 L

*These samples collected by ExPonent in November of 2009

Table 2.2: Macroinvertebrate Tissue Sample Details

Sample Location	Sample Dates		
	December 2010 (Time 0)	**June 2011 (Time 1)**	**October 2011 (Time 2)**
Form Sed A	20 ml vial	20 ml vial	40 ml vial
Form Sed B	20 ml vial	20 ml vial	40 ml vial
Form Sed C	20 ml vial	20 ml vial	40 ml vial
APG-05/09 A	20 ml vial	20 ml vial	40 ml vial
APG-05/09 B	20 ml vial	20 ml vial	40 ml vial
APG-05/09 C	20 ml vial	*Not Sampled*	40 ml vial
APG-04/07 A	20 ml vial	20 ml vial	40 ml vial
APG-04/07 B	20 ml vial	20 ml vial	40 ml vial
APG-04/07 C	20 ml vial	*Not Sampled*	40 ml vial
APG-22/23 A	20 ml vial	20 ml vial	40 ml vial
APG-22/23 B	20 ml vial	20 ml vial	40 ml vial
APG-22/23 C	20 ml vial	*Not Sampled*	40 ml vial
APG-15/12 A	20 ml vial	20 ml vial	40 ml vial
APG-15/12 B	20 ml vial	20 ml vial	40 ml vial
APG-15/12 C	20 ml vial	*Not Sampled*	40 ml vial
APG-06/24 A	20 ml vial	20 ml vial	40 ml vial
APG-06/24 B	20 ml vial	20 ml vial	40 ml vial
APG-06/24 C	20 ml vial	*Not Sampled*	40 ml vial
Lot #11-017 (Test Initiation)	20 ml vial	*Not Sampled*	*Not Sampled*
Lot #11-017 (Upon Receipt)	20 ml vial	*Not Sampled*	*Not Sampled*
Lot #11-018	20 ml vial	20 ml vial	*Not Sampled*
APG-02/08 A	20 ml vial	20 ml vial	40 ml vial
APG-02/08 B	20 ml vial	20 ml vial	40 ml vial
APG-02/08 C	20 ml vial	*Not Sampled*	40 ml vial
APG-11/13 A	20 ml vial	20 ml vial	40 ml vial
APG-11/13 B	20 ml vial	20 ml vial	40 ml vial
APG-11/13 C	20 ml vial	*Not Sampled*	40 ml vial
APG-14/10 A	20 ml vial	20 ml vial	40 ml vial
APG-14/10 B	20 ml vial	20 ml vial	40 ml vial
APG-14/10 C	20 ml vial	*Not Sampled*	40 ml vial
APG-21/20 A	20 ml vial	20 ml vial	40 ml vial
APG-21/20 B	20 ml vial	20 ml vial	40 ml vial
APG-21/20 C	20 ml vial	*Not Sampled*	40 ml vial
APG-01/03 A	20 ml vial	20 ml vial	40 ml vial
APG-01/03 B	20 ml vial	20 ml vial	40 ml vial
APG-01/03 C	20 ml vial	*Not Sampled*	40 ml vial
APG-16/17 A	*Not Sampled*	20 ml vial	40 ml vial
APG-16/17 B	*Not Sampled*	20 ml vial	40 ml vial
APG-16/17 C	*Not Sampled*	*Not Sampled*	40 ml vial
APG-18/19 A	*Not Sampled*	20 ml vial	40 ml vial
APG-18/19 B	*Not Sampled*	20 ml vial	40 ml vial
APG-18/19 C	*Not Sampled*	*Not Sampled*	40 ml vial

2.3 In Situ PED Samplers

Polyethylene Device samplers (PEDs) were deployed in December, 2010 for 10 months and recovered from the field in October, 2011. Sample extracts were prepared in the field and shipped to UNH laboratories. Samples were received on October 17, 2011. Upon receipt, it was determined that several samples were damaged in transit.

Sample Location	**Sample Dates**		
	December 2010 (Time 0)	**June 2011 (Time 1)**	**October 2011 (Time 2)**
APG-02	60 ml Vial	60 ml Vial	60 ml Vial
APG-08	60 ml Vial	60 ml Vial	60 ml Vial
APG-22	60 ml Vial	60 ml Vial	*Sample Damaged*
APG-23	60 ml Vial	60 ml Vial	*Sample Damaged*
APG-05	60 ml Vial	60 ml Vial	60 ml Vial
APG-09	60 ml Vial	60 ml Vial	*Sample Damaged*
APG-11	60 ml Vial	60 ml Vial	60 ml Vial
APG-13	60 ml Vial	60 ml Vial	*Sample Damaged*
APG-06	60 ml Vial	60 ml Vial	*Sample Damaged*
APG-24	60 ml Vial	*Sample Damaged*	60 ml Vial
APG-20	60 ml Vial	60 ml Vial	60 ml Vial
APG-21	60 ml Vial	60 ml Vial	60 ml Vial
APG-01	60 ml Vial	60 ml Vial	60 ml Vial
APG-03	60 ml Vial	60 ml Vial	60 ml Vial
APG-10	*Sample Damaged*	*Sample Damaged*	60 ml Vial
APG-14	60 ml Vial	60 ml Vial	*Sample Damaged*
APG-04	60 ml Vial	*Sample Damaged*	60 ml Vial
APG-07	60 ml Vial	60 ml Vial	60 ml Vial
APG-12	60 ml Vial	60 ml Vial	60 ml Vial
APG-15	60 ml Vial	60 ml Vial	60 ml Vial

3.0 Methods

Samples collected from the three sampling events were prepared and analyzed for general environmental characteristics and PCB concentrations. General envornmental characterization included evaluating the moisture content, natural organic carbon and black carbon concentrations within the bulk hydric soil. PCB presence and concentration was deterimined in the bulk phase, pore water and macroinvertebrate receptor ti

3.1 Moisture Content

The moisture content of the hydric soil samples were measured following homogenization procedures in accordance with Gustafsson, 1997. Approximately 5g to 10g of soil was massed on an analytical scale (Sartorius BP121S) and dried at 60°C for 24 hours in a laboratory oven (Fisher Scientific). At the conclusion on the 24 hours, samples were massed a second time to determine the moisture content. Percentages are reported per bulk mass (Eq. 2.1)

Equation 3.1: Percent Moisture Content

$$\%Moisture\ Content = (Mass_{Bulk} - Mass_{Dry})/Mass_{Bulk}$$

3.2 Natural Organic Carbon

The natural organic carbon was measured in accordance with Gustafsson, 1997. Previously dried samples (Section 3.1) were cooled and stored in a desiccant chamber (Nalge/Sybron) prior to analysis. The sample particle size was reduced with a mortar and pestle to below 500 µm in diameter. Approximately 1.5 g of the dried/crushed sample was transferred to a small 13 g crucible and placed in a muffle furnace (Fisher Scientific) set at 375°C for 24 hours. Samples were cooled in a desicator for a half hour and massed to determine the mass loss. Natural organic cabon was calculated as the mass of natural organic carbon (non-soot) per dry soil mass (Equation 3.2).

Equation 3.1: Percent Moisture Content

$$\%Natrual\ Organic\ Carbon = (Mass_{Dry} - Mass_{375C})/Mass_{Dry}$$

3.3 Black Carbon

The black carbon (activated carbon) content within the hydric soil was determined following a method described in Grossman and Ghosh, 2009. Samples were dried at 60°C, crushed and sieved to below xx µm. Samples were then pretreated with a 0.1 M acid-dichromate solution to remove any natural organic matter at 60°C for 30 minutes. The acid-dichromate solution was then quenched with methanol and decanted. The pre-treatment step was then repeated a second time. Black carbon content was then determined with a CHN analyzer (Perkin Elmer 2400 Series II). Samples are reported as % carbon.

3.4 Bulk Hydric Soil Extraction and Sample Preparation

Bulk hydric soils were extracted for analytical analysis following a modified EPA 8082A method. Prior to extraction, approximately 5 to 10g of wet sediment was chemically dried with the addition of sodium sulfate in a desiccant chamber. The samples were then placed in stainless steel ASE Cells and extracted with a Dionex ASE 200 Accelerated Solvent Extractor in a 1:1 Hexane/Acetone mixture at 100^{o}C and 1,500 psi for extraction. After extraction, the samples were exchanged to hexane and concentrated to 5 ml under ultra-high purity nitrogen. Excess water was removed during the solvent exchange with sodium sulfate. Following extraction, it was determined that the extracts required an additional “clean up” step prior to analysis. Size partitioning exclusion was conducted following EPA 3630C, using Thermo Scientific HyperSep Si Packs. Collected eluate was then concentrated to 10 ml (as hexane). Samples were transferred to 16 ml amber vials and stored at 4°C until analysis.

3.5 Pore Water Extraction and Sample Preparation

PCB concentrations in the pore water phase were determined with a Polyoxymethylene (POM) passive sampling extraction method described by Hawthorne et al., 2009. POM strips (4cm by 6cm) were prepared and cleaned prior to analysis. Strips were cleaned in first via sonication in hexane, then in methanol, each for 2 hours. POM strips were then rinsed and stored in reverse osmosis (RO) water until sampling.

The pore water was passively sampled from the bulk hydric soil samples. Twenty grams of wet soil was mixed with 40 ml of sodium azide solution (50 mg/ml) in a muffled 60 ml amber vial for each sample evaluated. A single strip of POM was also placed in the reaction vial which was immediately capped and placed on a vertical rotary wheel mixer. Reactors were rotated for 28 days, to achieve equilibrium between the POM and PW phases. At the conclusion of the equilibration period, POM strips were recovered from each reaction vial and rinsed for 15 seconds under RO water, then physically dried with a kimwipe. The strips were then immediately placed 40 ml of 1:1 hexane/acetone solution and sonicated for 1 hour. Solvent extract were concentrated and exchanged to hexane under UHP nitrogen to 10 ml. Samples were then transferred to 16 ml amber vials and stored at 4°C until analysis.

3.5 *In Situ* Pore Water Sampling, Extraction and Preparation

Pore water concentrations were also sampled *in situ* with Polyethylene Devices (PEDs) consistent with the methodology described in Adams et. al., 2009. Twenty 15in by 12in PED frames, with approximately a 6in x 12in exposed section of PE in the center, were deployed in December 2010 and left to equilibrate with the in situ pore water for 10 months in 20 of the treatment plots. Samplers were installed so that the PE was exposed to top six in of sediment to evaluate the pore water concentrations with vertical depth (profile). In October the samplers were recovered from the field. The polyethylene sheeting was immediately rinsed with RO water to remove any soil/debris material by field personnel. The top two inches of PE (exposed to the top 2 in. of soil) was cut from the frame, followed by the next 2 in. (exposed to the -2 to -4 in. layer of soil) and lastly the bottom two inches of exposed PE (exposed to the -4 in. to -6 in. layer of soil). As each section was removed, it was placed in a 40 ml VOA vial. A 1:1 Hexane/Acetone mixture was later added to extract the PE. Samples were then shipped to UNH laboratories for analysis.

Upon arrival, each sample vial was inspected and sonicated for 2 hours. The solvent extracts were then removed from each vial, exchanged to hexane and concentrated to 10 ml. Samples were transferred to 16 ml amber vials and stored at 4°C until analysis.

3.6 Macroinvertebrate Tissue Extraction and Sample Preparation

Bioaccumulation studies were conducted with composite hydric soil samples from multiple plots containing the same treatment. Soils were shipped directly to biological laboratories from the field site for the 28 day exposure period using Lumbriculus variegatus. At the conclusion of the exposure period, the lumbriculus were recovered, depurated and frozen. Frozen tissue samples were then shipped to UNH laboratories for chemical analysis.

Upon receipt, samples were masticated in sodium sulfate and Ottawa sand and extracted with an Accelerated Solvent Extractor (Dionex ASE 200) in a 1:1 Hexane/Acetone mixture at 100^{o}C and 1,500 psi. Following extraction, the solvent extract was concentrated to 5 ml under nitrogen. Excess water was removed during this process chemically with sodium sulfate. A size partitioning exclusion clean up method using Thermo Scientific HyperSep Si Packs was then applied to the samples to remove interfering compounds (EPA, 3630C). The collected eluant was then again reduced under nitrogen and concentrated to 10 ml in hexane. Final extracts were transferred to 16 ml amber vials until GC/MS analysis was conducted.

3.7 PCB Analytical Analysis

Two PCB analyses were conducted within this study following a modified EPA 8082A method (GC/MS was used in place of GC/ECD). The first preliminary qualitative analysis was conducted to determine the major contributing congeners present at the treatment site. The second analysis was conducted to quantify the concentration of those major congeners within the bulk hydric soil, pore water and macroinvertebrate receptor tissue.

A 209 Congener Mix PCB standard, manufactured by AccuStandard (New Haven, CT) was used for the qualitative analysis to characterize the primary congeners present within the bulk soil and pore water matrices. Selective ion monitoring was used to compare chromatographs between the standard and samples. Presence/absence was determined based upon the similarity between retention time and ion mass/spin (m/z) between the standards and samples. Twenty-nine congeners were identified from the 209-congener mix within the bulk soil, pore water and receptor tissue matrices using GC/MS; it was determined that those 29 congeners accounted for >99% of the signal within all the samples evaluated. The identified individual congeners' standards (AccuStandard) were then combined to formulate a quantification standard.

A modified EPA 8082 method using GC/MS was used to identify all congeners present in the bulk soil, pore water and receptor tissue. Those congeners were then quantified using a composite standard of the identified individual congener mixes. While EPA 1668 using high resolution GC/MS may have been able to achieve lower detection for the congeners observed and possibly identify the presence of others, it is the congeners that were present above detection limit that drove this analysis. Therefore, a separate analysis would not have likely yielded different results. No shifts were observed between pre- and post-treatment monitoring events. A slight concentration shift in low molecular weight homologs was observed between the bulk soil and pore water.

Total PCBs were measured following EPA's method 8082A: Polychlorinated Biphenyls (PCBs) by Gas Chromatography. Under this methodology, the concentration of PCBs as Aroclors or as individual PCB congeners may be determined in extracts from solid, tissue, and aqueous matrices. The holding time of samples depends on what matrix it comes from; congener-specific PCBs from a pore water matrix are held 7 days to extraction and 40 days from extraction to analysis, whereas total PCBs in a tissue matrix are held for twice the length of time to extraction.

A 30 congener PCB standard (29 congeners + a surrogate standard) was custom fabricated at UNH from individual congener standards distributed by AccuStandard. The custom standard was then prepared in dilution to establish a calibration curve for the quantitative study. Both analyses were conducted on a Varian CP3800 Gas Chromatographer/Saturn 2200 Mass Spectrometer. One microliter (µL) of sample was injected onto a DB-5 type capillary column (Varian Factor Four VF-5ms), ionized via electromagnetic ionization and detected with selective monitoring ion trap technology.

PCB concentrations presented in the results section of this document are the total cumulative PCB concentrations (99% of total PCBs composed of the 29 primary congeners). Congener concentrations

below the reporting limit were included in the cumulative total. The 29 congeners quantified are shown in Table 3.1below, along with their associated homolog group and reporting limits.

Table 3.1: PCB Congener Quantification

Congener	Associated Homolog Group	Solvent Concentration Reporting Limit (ng/mL)	POM Concentration Reporting Limit (ng/g)
1	H1	25	37153.52291
3	H1	25	37153.52291
4	H2	25	37153.52291
9	H2	25	48977.88194
6	H2	12.5	54954.08739
5	H2	25	54954.08739
19	H3	12.5	131825.6739
12+13+17	H2/H3	50	158489.3192
15	H2	25	134896.2883
27	H3	12.5	257039.5783
32	H3	12.5	323593.6569
26	H3	12.5	257039.5783
28	H3	20	478630.0923
53+33	H3/H4	35	446683.5922
51	H4		
22+45	H3/H4	25	295120.9227
52	H4	10	446683.5922
49	H4	20	676082.9754
38+75	H3/H4	45	1348962.883
44	H4	25	446683.5922
42	H4	25	436515.8322
64	H4	20	630957.3445
121+66	H4/H5	40	2089296.131

4.0 Results

4.1 Moisture Content Results

Moisture contents were measured for each individual sampling plot. The average moisture content of the hydric soil samples from all three sampling events was 61.9%, with a standard deviation of 9.4%. The maximum observed moisture was 76.9% and the minimum was 36.2%. All measurements are provided in Table 4.1.

4.2 Natural Organic Carbon Results

Natural Organic Carbon was measured for each individual treatment plot location within each sampling event (multiple plot composite sample were not measured). The average natural organic carbon observed on the site was 17.3% with a standard deviation of 0.56%. The maximum NOC observed was 31.2% and minimum was 4.2% (NOC is reported per dry soil mass). Analytical procedural errors occurred

while evaluating samples APG-11(T1), APG-10(T2) and APG-11(T2), therefore concentrations are not reported.

Table 4.1: Bulk Hydric Soil Moisture Content

Sample	T0- December 2010	T1- June 2011	T2- October 2011
APG-01	51.73%	59.80%	42.47%
APG-02	51.67%	56.69%	70.21%
APG-03	46.15%	40.55%	48.83%
APG-04	62.01%	67.09%	68.23%
APG-05	45.56%	53.44%	62.64%
APG-06	36.20%	62.88%	63.57%
APG-07	40.32%	52.18%	45.90%
APG-08	50.15%	59.38%	60.95%
APG-09	61.37%	71.26%	69.95%
APG-10	68.46%	59.70%	68.50%
APG-11	72.86%	72.81%	56.57%
APG-12	72.35%	74.19%	65.93%
APG-13	60.39%	69.01%	52.73%
APG-14	65.47%	54.48%	75.27%
APG-15	63.47%	62.04%	68.69%
APG-16	65.71%	67.85%	73.62%
APG-17	60.46%	65.99%	67.39%
APG-18	67.67%	63.35%	66.54%
APG-19	56.85%	62.33%	66.37%
APG-20	69.60%	76.93%	58.17%
APG-21	70.61%	72.47%	71.84%
APG-22	58.77%	65.50%	76.03%
APG-23	49.45%	61.38%	68.84%
APG-24	54.82%	66.71%	64.97%

4.3 Black Carbon Results

The Black Carbon (BC) concentration was measured for each individual treatment plot location within each sampling event (multiple plot composite sample were not measured). The average BC observed on the site prior to the treatment application was 1.13% with a standard deviation of 0.62%. Following treatment application, BC concentrations increased within the sampling plots which contained treatment (AC Slurry, AquaBlok or SediMite). Average BC concentrations at the 6 month sampling event were 3.08% (SD = 1.15%) and 1.78% (SD = 0.60%) at the 10 month sampling event. Black carbon concentrations remained relatively stable in the non-treated test plots (Control and Sand Control). Average 6 month concentrations were 0.98% (SD = 0.78%) and 1.09% (SD = 0.53%) at 10 months. Analytical procedural errors occurred while evaluating samples APG-12(T2) and APG-14(T2), therefore concentrations are not reported.

Table 4.2: Natural Organic Carbon

Sample	T0- December 2010	T1- June 2011	T2- October 2011
APG-01	22.31%	14.14%	7.33%
APG-02	18.75%	23.87%	24.41%
APG-03	6.73%	6.54%	8.73%
APG-04	13.49%	19.18%	13.57%
APG-05	10.13%	14.11%	14.16%
APG-06	6.28%	15.48%	14.35%
APG-07	4.86%	10.20%	4.62%
APG-08	9.53%	12.63%	13.42%
APG-09	15.13%	19.36%	17.13%
APG-10	22.92%	13.76%	*Not Measured*
APG-11	31.12%	*Not Measured*	*Not Measured*
APG-12	26.48%	21.95%	16.67%
APG-13	22.62%	24.92%	16.68%
APG-14	18.83%	8.68%	22.38%
APG-15	15.93%	12.36%	24.22%
APG-16	18.55%	22.16%	25.30%
APG-17	15.94%	20.13%	18.98%
APG-18	19.70%	16.59%	18.61%
APG-19	19.60%	12.65%	16.50%
APG-20	19.33%	26.76%	13.71%
APG-21	22.28%	26.89%	24.70%
APG-22	16.36%	18.01%	27.39%
APG-23	25.94%	18.11%	22.02%
APG-24	11.32%	17.14%	21.10%

Table 4.3: Black Carbon Concentrations

Sample	T0- December 2010	T1- June 2011	T2- October 2011
APG-01	1.22%	0.43%	1.38%
APG-02	0.67%	1.18%	2.16%
APG-03	0.37%	0.47%	0.38%
APG-04	1.20%	1.51%	1.07%
APG-05	0.51%	2.57%	2.43%
APG-06	0.20%	2.66%	0.32%
APG-07	0.73%	0.76%	0.66%
APG-08	0.37%	0.88%	2.28%
APG-09	1.25%	2.56%	2.82%
APG-10	1.40%	0.37%	1.89%
APG-11	1.10%	4.87%	2.20%
APG-12	2.56%	2.69%	*Not Measured*
APG-13	1.23%	3.43%	2.05%
APG-14	0.74%	0.79%	*Not Measured*
APG-15	1.39%	0.82%	1.15%
APG-16	1.32%	3.83%	1.47%
APG-17	2.45%	2.94%	1.44%
APG-18	2.10%	4.50%	1.58%
APG-19	1.27%	1.69%	0.96%
APG-20	1.33%	3.76%	1.79%
APG-21	1.37%	3.07%	1.44%
APG-22	1.18%	3.88%	1.72%
APG-23	0.37%	4.40%	1.97%
APG-24	0.72%	3.14%	1.86%

4.4 Bulk Hydric Soil PCB Results

Bulk hydric soil samples evaluated by UNH had a wide range in concentration (over 4 orders of magnitude) from a maximum of 266 mg/kg to a minimum 0.013 mg/kg. The average concentration over the site was 27.8 mg/kg with a standard deviation of 49.6 mg/kg. PCB concentrations are presented for each treatment plot in Table 4.4 and graphically in Figure 4.1. Data is organized by similar treatment type. Concentrations are reported as milligram PCB per kilogram hydric soil. Analytical procedural errors occurred while evaluating samples APG-22(T1), APG-09(T1), APG-24(T1), APG-16(T2) and APG-07(T2); therefore concentrations are not reported.

Table 4.4: Bulk Hydric Soil PCB Concentrations

Treatment	Sample	(T0) December 2010	(T1) June 2011	(T2) October 2011
		(mg/kg)		
Slurry Spray	APG-02	8.70E+00	1.17E+01	2.48E+01
	APG-08	4.08E-01	1.51E+00	6.42E+00
	APG-02/08	1.94E+00	3.48E+00	1.84E+00
	APG-22	1.72E-02	*Not Reported*	2.07E-01
	APG-23	1.69E-02	2.70E-01	5.10E-01
	APG-22/23	5.29E-02	1.25E-02	2.95E-01
AquaBlok	APG-05	1.57E+00	6.29E+00	9.42E+00
	APG-09	1.65E+01	*Not Reported*	3.47E+01
	APG-05/09	9.09E+00	1.50E+01	3.35E+01
	APG-11	1.58E-01	6.93E-01	5.63E-01
	APG-13	1.79E+01	1.36E+01	1.32E+02
	APG-11/13	*Not Sampled*	1.39E+01	1.23E+01
	APG-06	1.05E+02	1.51E+02	9.64E-01
	APG-24	3.03E-02	*Not Reported*	8.50E-01
	APG-06/24	8.21E+01	5.39E+01	2.32E+02
	APG-20	1.35E+01	1.04E+01	3.14E+01
	APG-21	6.31E-01	4.53E-01	2.47E+00
	APG-20/21	*Not Sampled*	2.67E-01	8.71E+00
SediMite	APG-16	4.88E+00	7.35E+00	*Not Reported*
	APG-17	4.56E+00	5.93E+00	1.12E+01
	APG-16/17	*Not Sampled*	5.58E+00	1.52E+01
	APG-18	1.09E+01	8.54E+00	2.63E+01
	APG-19	3.24E+01	1.54E+02	1.19E+02
	APG-18/19	*Not Sampled*	7.28E+00	5.63E+01
Sand Control	APG-01	7.69E+00	5.14E-01	2.66E+02
	APG-03	2.91E+01	7.82E+01	1.71E+02
	APG-01/03	1.09E+01	1.22E+02	7.92E+01
	APG-10	2.72E-01	8.16E-02	3.35E+00
	APG-14	7.66E+00	1.50E+01	1.42E+01
	APG-10/14	7.10E+00	6.65E+00	5.34E+00
Control	APG-04	4.23E+00	1.45E+01	2.48E+01
	APG-07	5.90E+01	8.21E+01	*Not Reported*
	APG-04/07	2.89E+01	2.16E+01	9.21E+01
	APG-12	1.81E-01	1.76E+00	4.77E+00
	APG-15	1.25E+00	4.33E+00	1.40E+01
	APG-12/15	*Not Sampled*	5.00E+00	3.24E+00

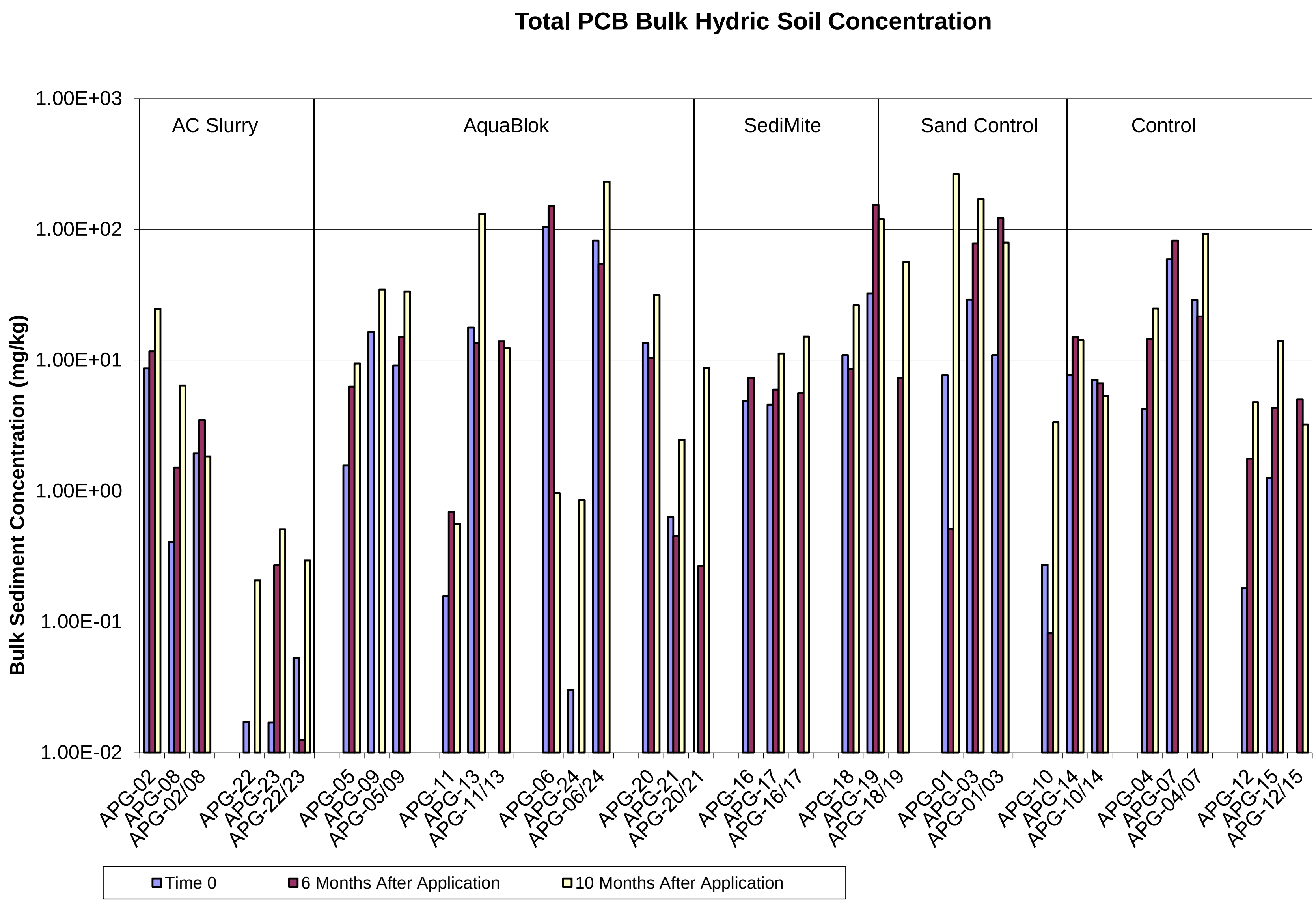

Figure 4.1: Bulk Hydric Soil Concentrations measured In Situ

4.4 Pore Water PCB Results

Pore water PCB concentrations were determined from the same composite hydric soil samples collected from the treatment area in the bulk sediment evaluation. Pore water sampling was conducted with POM passive samplers as described previously in Section 3.4. Pore water concentrations within the testing area were also found to be highly variable. Concentrations prior to the application of reactive treatments ranged over 5 orders of magnitude (maximum 3.73×10^{-02} mg/L; minimum 5.69×10^{-07} mg/L) with an average concentration of 2.25×10^{-03} mg/L and a large standard deviation (7.07×10^{-03}). Following the application of the reactive amendment products, reductions in pore water concentrations were observed for greater than 80% of the treatment plots containing treatments (not controls) during at least one post treatment sampling event. PCB concentrations are presented for each treatment plot in Table 4.5 and graphically in Figure 4.2. Data is presented by treatment plot and organized by similar treatment type. Concentrations are reported as milligram PCB per liter pore water.

4.4 In Situ Pore Water PCB Results

Pore water concentrations were also measured *in situ* with polyethylene device (PED) passive samplers to evaluate the PCB concentration profile with depth. Data is presented in Table 4.6 by treatment plot and depth. Treatment plots are organized into similar treatment types. The average concentration measured was 1.61×10^{-03} mg/L (SD = 5.65×10^{-03} mg/L). The maximum concentration measured was 2.70×10^{-02} mg/L and the minimum was 8.90×10^{-07}. Results are also reported graphically in Figure 4.3. All results are reported as mg PCB per L of pore water. Several samples (10) were damaged in transit between the field and laboratory including APG-10(Top), APG-24(Mid), APG-10(Mid), APG-04(Mid), APG-22(Bottom), APG-23(Bottom), APG-09(Bottom), APG-13(Bottom), APG-06(Bottom) and APG-14(Bottom); therefore these results are not reported.

4.4 Macroinvertebrate Receptor Tissue PCB Results

Tissue concentrations from benthic organisms exposed to sediments within the testing area were found to be highly variable. Concentrations prior to the application of reactive treatments ranged over 4 orders of magnitude (maximum $3.57 \times 10^{+02}$ mg/L; minimum 4.33×10^{-02} mg/L) with an average concentration of $2.25 \times 10^{+01}$ mg/L and a large standard deviation ($1.21 \times 10^{+02}$). Following the application of the reactive amendment products, reductions in tissue concentration were observed for all of the treatments in which Time-0 data was available (AC Slurry and AquaBlok). Time-0 concentrations for the SediMite treatment plots are not available. Tissue concentrations were observed to fluctuate in the "Sand" and "No Treatment" Control plots in the post treatment sampling events. Results are presented in Table 4.7 and Figure 4.4. Results are present by treatment plot and organized by similar treatment type. All results are reported as mg PCB per kg wet tissue mass.

Table 4.5: PCB Total Pore Water Concentrations

Treatment	Sample	(T0) December 2010	(T1) June 2011	(T2) October 2011
		(mg/L)		
Slurry Spray	**APG-02**	7.11E-05	2.71E-05	3.25E-05
	APG-08	3.30E-05	8.14E-06	2.45E-05
	APG-02/08	3.90E-05	1.15E-05	4.49E-06
	APG-22	5.96E-07	1.62E-06	4.18E-06
	APG-23	7.17E-07	2.87E-07	3.33E-06
	APG-22/23	3.49E-06	2.58E-06	1.53E-06
AquaBlok	**APG-05**	4.70E-05	2.07E-06	8.74E-06
	APG-09	4.35E-04	7.38E-05	9.37E-06
	APG-05/09	3.40E-04	2.87E-06	5.59E-06
	APG-11	7.19E-07	1.46E-06	2.07E-05
	APG-13	2.81E-04	6.10E-06	9.14E-05
	APG-11/13	6.47E-05	6.91E-06	3.17E-06
	APG-06	3.73E-02	3.24E-04	7.22E-06
	APG-24	1.23E-06	2.23E-06	5.10E-06
	APG-06/24	1.58E-02	1.05E-04	4.35E-03
	APG-20	3.88E-04	1.09E-05	5.39E-05
	APG-21	8.72E-06	1.72E-06	1.25E-05
	APG-20/21	*Not Sampled*	1.87E-06	1.51E-05
SediMite	**APG-16**	7.69E-05	3.37E-05	1.95E-05
	APG-17	3.35E-05	1.65E-05	6.54E-05
	APG-16/17	*Not Sampled*	2.53E-05	4.65E-05
	APG-18	1.59E-04	3.38E-05	2.11E-04
	APG-19	1.57E-03	4.19E-03	1.84E-03
	APG-18/19	*Not Sampled*	1.17E-05	2.14E-04
Sand Control	**APG-01**	5.95E-06	6.73E-06	1.76E-03
	APG-03	4.29E-03	2.07E-02	1.19E-02
	APG-01/03	1.67E-03	1.18E-02	6.11E-03
	APG-10	2.43E-06	9.30E-06	7.26E-06
	APG-14	1.72E-04	2.15E-04	1.09E-04
	APG-10/14	8.37E-05	1.30E-04	4.25E-05
Control	**APG-04**	1.67E-04	1.56E-04	2.46E-04
	APG-07	6.19E-03	5.41E-03	3.62E-02
	APG-04/07	2.62E-03	2.20E-04	4.87E-03
	APG-12	3.99E-06	9.63E-06	2.48E-05
	APG-15	3.87E-05	7.43E-05	1.00E-04
	APG-12/15	*Not Sampled*	3.52E-05	1.27E-05

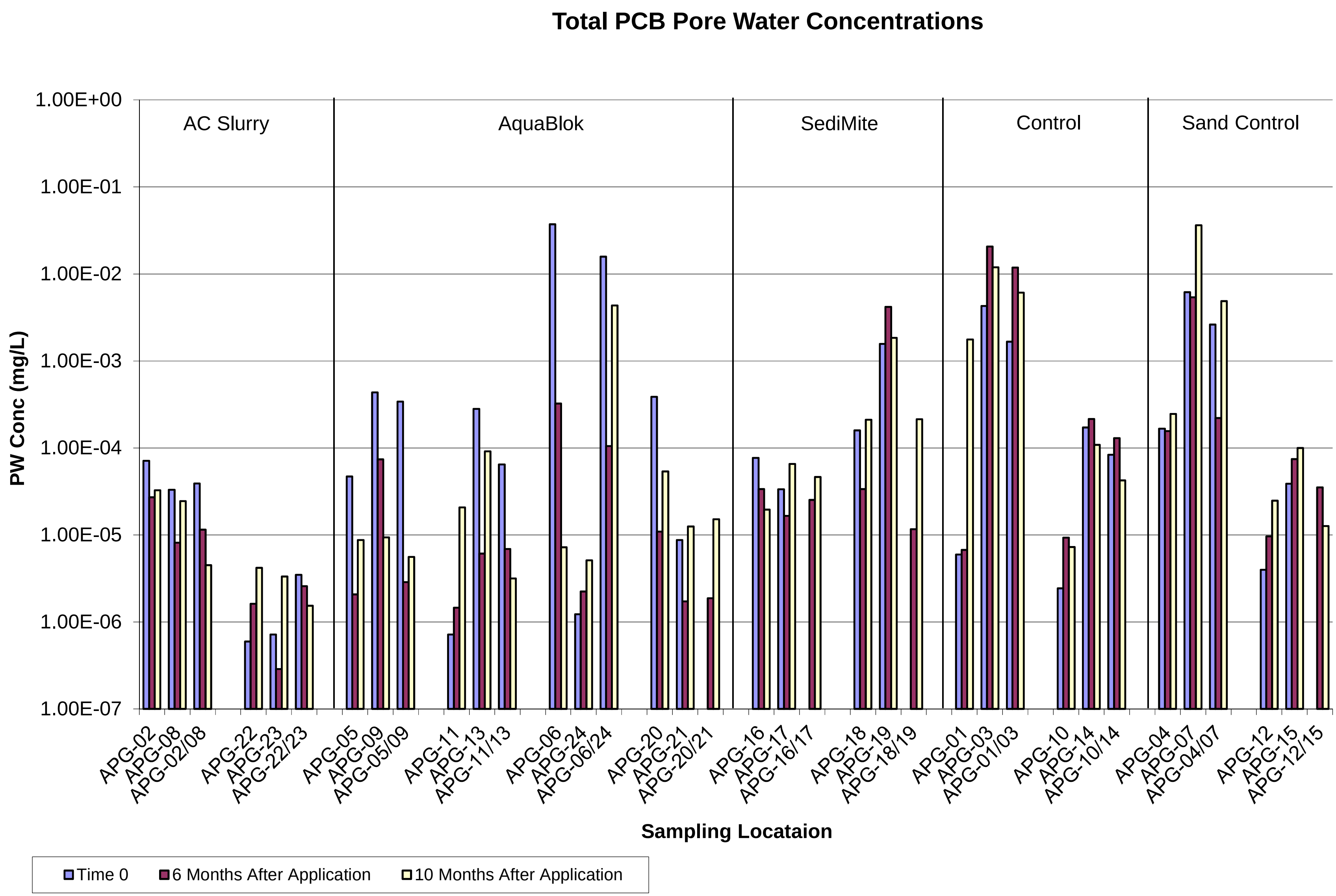

Figure 4.2: Pore Water Concentrations

Table 4.6: PCB Pore Water Concentrations Measured In Situ

Treatment	Sample	Top (0in to 2in)	Middle (2in to 4in)	Bottom (4in to 6in)
			(mg/L)	
Slurry Spray	APG-02	9.29E-07	1.07E-06	1.84E-05
	APG-08	7.54E-06	4.31E-06	7.32E-06
	APG-22	1.40E-06	1.89E-06	*Not Reported*
	APG-23	4.02E-05	1.95E-06	*Not Reported*
AquaBlok	APG-05	3.06E-06	3.90E-06	2.58E-05
	APG-09	5.32E-06	9.30E-06	*Not Reported*
	APG-11	3.65E-05	3.23E-05	1.43E-05
	APG-13	2.57E-06	2.48E-06	*Not Reported*
	APG-06	4.05E-06	6.31E-05	*Not Reported*
	APG-24	1.74E-06	*Not Reported*	1.68E-06
	APG-20	6.47E-06	1.44E-06	1.39E-06
	APG-21	2.24E-06	3.07E-06	6.99E-06
Sand Control	APG-01	8.90E-07	1.81E-06	3.18E-06
	APG-03	1.52E-03	2.37E-02	1.87E-02
	APG-10	*Not Reported*	*Not Reported*	2.27E-06
	APG-14	3.34E-04	6.00E-05	*Not Reported*
Control	APG-04	3.16E-05	*Not Reported*	9.22E-05
	APG-07	1.46E-03	6.89E-03	2.70E-02
	APG-12	8.65E-06	1.16E-05	2.65E-05
	APG-15	2.30E-05	7.25E-05	1.43E-04

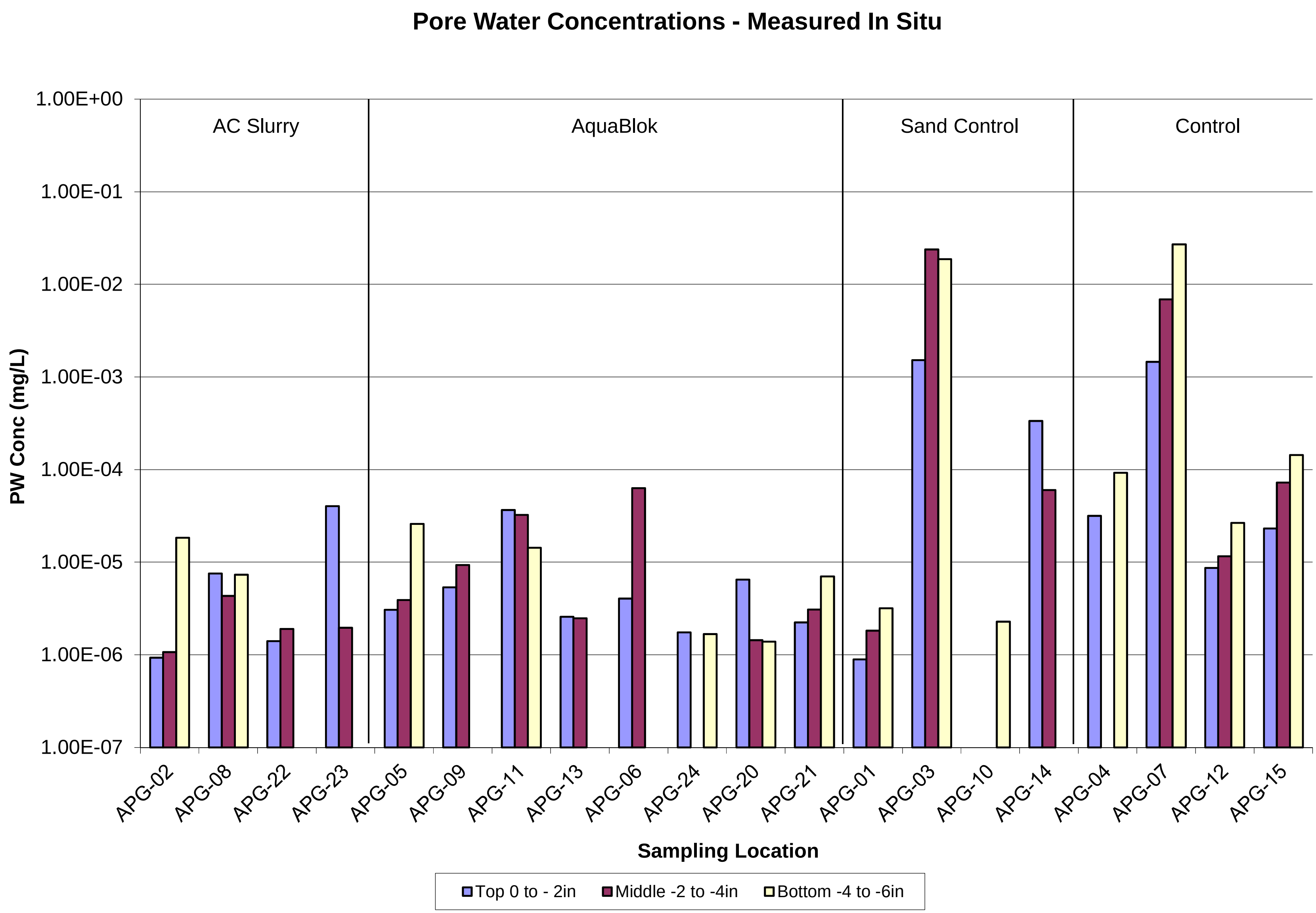

Figure 4.3: Pore Water Concentrations measured In Situ

Table 4.7: PCB Receptor Tissue Concentrations

Treatment	Sample	(T0) December 2010	(T1) June 2011	(T2) October 2011
		(mg/kg)		
Slurry Spray	**APG-02/08a**	3.10E+00	7.47E-01	3.99E-02
	APG-02/08b	3.66E+00	3.72E-01	1.89E-02
	APG-02/08c	3.01E+00	*Not Sampled*	1.51E-02
	APG-22/23a	2.43E-02	1.95E-02	0.00E+00
	APG-22/23b	4.10E-02	0.00E+00	0.00E+00
	APG-22/23c	6.45E-02	*Not Sampled*	0.00E+00
AquaBlok	**APG-05/09a**	2.11E+01	7.59E-01	1.72E-02
	APG-05/09b	2.71E+01	1.13E-01	3.37E-02
	APG-05/09c	2.80E+01	*Not Sampled*	3.61E-02
	APG-11/13a	1.42E+01	2.76E-02	3.77E-01
	APG-11/13b	1.42E+01	3.56E-02	3.33E+00
	APG-11/13c	1.46E+01	*Not Sampled*	7.85E-01
	APG-06/24a	2.37E+02	4.52E-01	4.99E+00
	APG-06/24b	5.32E+02	1.12E+00	6.64E+00
	APG-06/24c	3.02E+02	*Not Sampled*	5.14E+00
	APG-20/21a	*Not Sampled*	1.77E-01	1.42E+00
	APG-20/21b	*Not Sampled*	2.15E-02	1.28E+00
	APG-20/21c	*Not Sampled*	*Not Sampled*	1.08E+00
SediMite	**APG-16/17a**	*Not Sampled*	1.41E+00	6.26E-01
	APG-16/17b	*Not Sampled*	4.19E+00	7.29E-01
	APG-16/17c	*Not Sampled*	*Not Sampled*	5.25E-01
	APG-18/19a	*Not Sampled*	6.43E+00	8.04E+00
	APG-18/19b	*Not Sampled*	1.59E+01	1.16E+01
	APG-18/19c	*Not Sampled*	*Not Sampled*	1.05E+01
Sand Control	**APG-01/03a**	1.73E+01	2.66E+01	3.19E+01
	APG-01/03b	2.27E+01	5.06E+01	2.23E+01
	APG-01/03c	2.43E+01	*Not Sampled*	1.91E+01
	APG-10/14a	1.00E+01	1.21E+01	3.08E-01
	APG-10/14b	0.00E+00	*Not Sampled*	3.41E-01
	APG-10/14c	1.27E+01	*Not Sampled*	1.11E-01
Control	**APG-04/07a**	8.53E+01	5.03E+01	4.12E+01
	APG-04/07b	7.42E+01	4.06E+01	4.09E+01
	APG-04/07c	5.23E+01	*Not Sampled*	4.35E+01
	APG-12/15a	*Not Sampled*	3.09E+00	1.41E+00
	APG-12/15b	*Not Sampled*	1.83E+00	9.96E-01
	APG-12/15c	*Not Sampled*	*Not Sampled*	1.11E+00

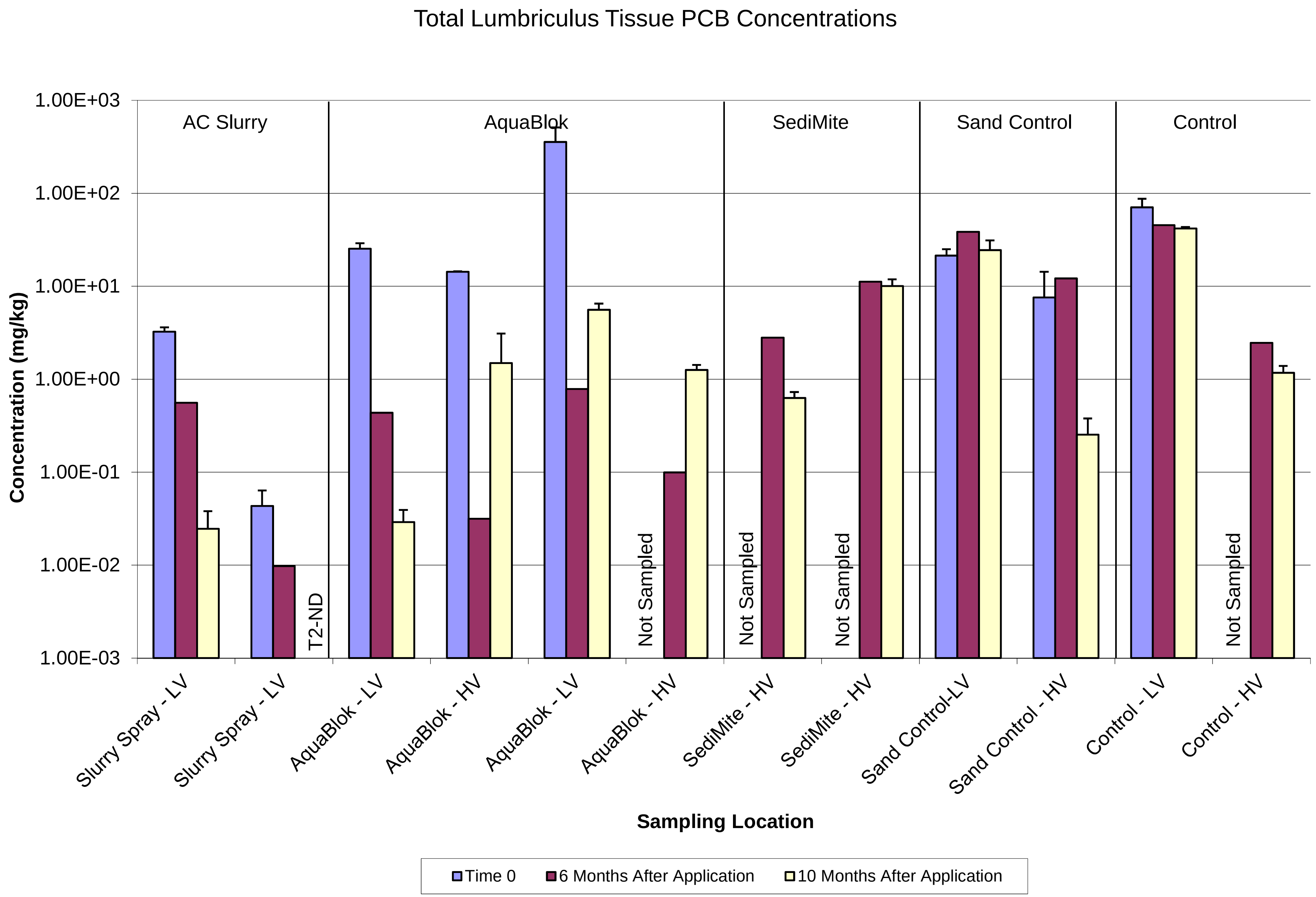

Figure 4.4: Macroinvertebrate Receptor Tissue PCB Concentrations

Appendix C: Biological Laboratory Reports

Aquatec Biological Sciences

Ecology | Environmental Toxicology | Natural Resource Assessments | Microbiology

February 14, 2012

Ryan S. McCarthy
Project Manager, Environment
AECOM
2 Technology Park Drive
Westford, MA 01886-3140
E-mail address: ryan.mccarthy@aecom.com

Dear Mr. McCarthy:

Attached please find an electronic copy (PDF) of the report on oligochaete, *Lumbriculus variegatus*, 28-day sediment bioaccumulation tests conducted on sediments collected from the APG site (tests completed during January-February 2012).

If you have any questions regarding the reported results, please contact Dr. Phil Downey or me.

Sincerely,

John Williams
Manager, Environmental Toxicology

This report consists of the following numbered pages:

SDG: 12957
Pages 1 - 44

Aquatec Biological Sciences, Inc.
273 Commerce Street
Williston, VT 05495
Tel: (802) 860 - 1638 Fax: (802) 658 - 3189

SDG: 12957
Project: 12008

AECOM
1000 Elm Street
8th Floor
Manchester, NH 03101

Tel: (978) 905-2312
Fax: (603) 622-8480

E-Mail: ryan.mcCarthy@aecom.com

Toxicity Detail Report

Project: APG Lumbriculus

100.3 Oligochaete, L. variegatus, Bioaccumulation Test for sediments

Species: *Lumbriculus variegatus* Reference: EPA/600/R-99/064 SOP: TOX3-006

Sample ID: **41930** : **Control**

Species: ***Lumbriculus variegatus***

Rep.	Initial Jar Weight (g)	Final tissue and Jar Weight (g)	Total Replicate Weight (g)
A	30.26	35.71	5.4
B	30.22	35.00	4.8
C	30.8	36.09	5.3

Sample ID: **41931** : **APG-05/09-100411**

Species: ***Lumbriculus variegatus***

Rep.	Initial Jar Weight (g)	Final tissue and Jar Weight (g)	Total Replicate Weight (g)
A	31.18	35.51	4.3
B	30.71	35.18	4.5
C	30.16	34.67	4.5

Sample ID: **41932** : **APG-01-03-100411**

Species: ***Lumbriculus variegatus***

Rep.	Initial Jar Weight (g)	Final tissue and Jar Weight (g)	Total Replicate Weight (g)
A	30.07	33.54	3.5
B	30.27	34.37	4.1
C	30.34	33.99	3.7

Sample ID: **41933** : **APG-06/24-100411**

Species: ***Lumbriculus variegatus***

Rep.	Initial Jar Weight (g)	Final tissue and Jar Weight (g)	Total Replicate Weight (g)
A	30.38	34.59	4.2
B	30.93	34.79	3.9
C	30.45	34.23	3.8

Toxicity Detail Report

Project: APG Lumbriculus

100.3 Oligochaete, L. variegatus, Bioaccumulation Test for sediments

Species: *Lumbriculus variegatus* Reference: EPA/600/R-99/064 SOP: TOX3-006

Sample ID: **41934 : APG-10/14-100411** Species: ***Lumbriculus variegatus***

Rep.	Initial Jar Weight (g)	Final tissue and Jar Weight (g)	Total Replicate Weight (g)
A	30.6	35.58	5.0
B	30.66	35.55	4.9
C	30.85	37.41	6.6

Sample ID: **41935 : APG-11/13-100411** Species: ***Lumbriculus variegatus***

Rep.	Initial Jar Weight (g)	Final tissue and Jar Weight (g)	Total Replicate Weight (g)
A	29.99	34.07	4.1
B	30.28	34.79	4.5
C	30.54	35.07	4.5

Sample ID: **41936 : APG-16/17-100411** Species: ***Lumbriculus variegatus***

Rep.	Initial Jar Weight (g)	Final tissue and Jar Weight (g)	Total Replicate Weight (g)
A	30.1	38.28	8.2
B	30.01	37.11	7.1
C	30.28	37.95	7.7

Sample ID: **41937 : APG-20/21-100411** Species: ***Lumbriculus variegatus***

Rep.	Initial Jar Weight (g)	Final tissue and Jar Weight (g)	Total Replicate Weight (g)
A	30.66	37.66	7.0
B	31	38.63	7.6
C	30.67	37.10	6.4

Sample ID: **41938 : APG-18/19-100411** Species: ***Lumbriculus variegatus***

Rep.	Initial Jar Weight (g)	Final tissue and Jar Weight (g)	Total Replicate Weight (g)
A	30.52	38.88	8.4
B	31.26	36.77	5.5
C	30.23	35.90	5.7

Sample ID: **41939 : APG-04/07-100411** Species: ***Lumbriculus variegatus***

Rep.	Initial Jar Weight (g)	Final tissue and Jar Weight (g)	Total Replicate Weight (g)
A	30.35	37.39	7.0
B	30.32	35.74	5.4
C	31.15	38.15	7.0

Toxicity Detail Report

Project: APG Lumbriculus

100.3 Oligochaete, L. variegatus, Bioaccumulation Test for sediments

Species: *Lumbriculus variegatus* Reference: EPA/600/R-99/064 SOP: TOX3-006

Sample ID: **41940 : APG-12/15-100511** Species: ***Lumbriculus variegatus***

Rep.	Initial Jar Weight (g)	Final tissue and Jar Weight (g)	Total Replicate Weight (g)
A	30.04	40.94	10.9
B	30.54	38.98	8.4
C	30.44	38.92	8.5

Sample ID: **41941 : APG-22/23-100511** Species: ***Lumbriculus variegatus***

Rep.	Initial Jar Weight (g)	Final tissue and Jar Weight (g)	Total Replicate Weight (g)
A	30.6	35.36	4.8
B	30.56	34.17	3.6
C	31.11	35.56	4.5

Sample ID: **41942 : APG-02/08-100511** Species: ***Lumbriculus variegatus***

Rep.	Initial Jar Weight (g)	Final tissue and Jar Weight (g)	Total Replicate Weight (g)
A	30.7	35.68	5.0
B	31.07	35.28	4.2
C	30.16	34.08	3.9

Aquatec Biological Sciences, Inc.
273 Commerce Street
Williston, VT 05495
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SDG: 12957
Project: 12008

AECOM
1000 Elm Street
8th Floor
Manchester, NH 03101

Tel: (978) 905-2312
Fax: (603) 622-8480
E-Mail: ryan.mcCarthy@aecom.com

Samples Received

Number	Sample Name	Date Time and Collected	Type
41930	Control	12/20/2011	Sediment
41931	APG-05/09-100411	10/4/2011 9:20:00 AM	Sediment
41932	APG-01-03-100411	10/4/2011 10:25:00 AM	Sediment
41933	APG-06/24-100411	10/4/2011 10:30:00 AM	Sediment
41934	APG-10/14-100411	10/4/2011 12:40:00 PM	Sediment
41935	APG-11/13-100411	10/4/2011 2:35:00 PM	Sediment
41936	APG-16/17-100411	10/4/2011 2:50:00 PM	Sediment
41937	APG-20/21-100411	10/4/2011 3:40:00 PM	Sediment
41938	APG-18/19-100411	10/4/2011 4:10:00 PM	Sediment
41939	APG-04/07-100411	10/4/2011 4:45:00 PM	Sediment
41940	APG-12/15-100511	10/5/2011 9:15:00 AM	Sediment
41941	APG-22/23-100511	10/5/2011 9:20:00 AM	Sediment
41942	APG-02/08-100511	10/5/2011 10:30:00 AM	Sediment

Submitted By:

Monday, February 06, 2012

Aquatec Biological Sciences, Inc.
273 Commerce Street
Williston, VT 05495
Tel: (802) 860 - 1638 Fax: (802) 658 - 3189

Aquatec Biological Sciences
Certification Number 1737

Quality Assurance Report

SDG: 12957
Project: 12008

AECOM
1000 Elm Street
8th Floor
Manchester, NH 03101

Tel: (978) 905-2312
Fax: (603) 622-8480

E-Mail: ryan.mcCarthy@aecom.com

Project: **APG Lumbriculus**

Narrative

Thirteen coolers containing sediments for the Aberdeen Proving Ground (APG) were shipped by AECOM on Monday December 19, 2011 for delivery to Aquatec Biological Sciences, Inc. (Aquatec). One set of five coolers was delivered to Aquatec on December 20, 2011. A sixth cooler from this shipment was mis-delivered by FedEx to TestAmerica and was retrieved by Aquatec also on December 20th. The second FEDEX shipment of the remaining seven coolers was received on December 21, 2011.

Control sediment, Sample 41930, consisting of natural sediment collected from the Lamoille River and Lake Arrowhead, Vermont) was included in the test array.

All sediments were prepared by press-sieving through a 0.5-mm mesh screen test to remove vegetative material and indigenous organisms. Three replicates of homogenized sediment from each sample were loaded into test containers on January 4, 2012 (Samples 41930, 41931, 41932, 41933, 41934, 41935, and 41936) and January 5, 2012 (Samples 41930, 41937, 41938, 41939, 41940, 41941, and 41942). For the control sediment (Sample 41930) two replicates were set up on January 4 while the third replicate was set up on January 5, 2012. According to a December 15, 2011 AECOM e-mail, the 13th sample, APG-DUP-100511, was not to be tested.

On January 5, 2012 Lumbriculus variegatus were added to each test chamber for the first six samples and on January 6, 2012 organisms were added to the second six samples. Three replicate subsamples of unexposed organisms (Time 0, pre-exposure), laboratory number 42054, were archived frozen on January 6, 2012.

The bioaccumulation tests ended on Day 28 (February 2, 2012 for the first group and February 3, 2012 for the second group). Organisms were removed from sediments using a combination of 0.5-mm and 0.25 mm stainless steel sieves. Organisms were depurated for a nominal 6-to-8 hour period in water and transferred to pre-weighed glass vials.

Organisms were stored frozen until they were shipped via Federal Express on February 7, 2012 to University of New Hampshire (UNH), Durham, New Hampshire. On February 8, Scott Greenwood confirmed all samples were received intact.

When hardness measurements of overlying water were made on Day 0, overlying water form samples 41937 (APG-20/21-100411) and 41941 (APG-22/23-100511) were unreadable due to

AECOM
1000 Elm Street
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Fax: (603) 622-8480

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Project: **APG Lumbriculus**

immediate color change during the titration. Overlying hardness measurements for these samples were repeated on Day 1 however the interference was still present. On Day 13, hardness was again measured on these samples. Sample 41937 still had interference, however sample 41941 had a normal hardness reading. Near the end of the test (Day 26) the overlying water hardness for these samples was within the normal range.

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E-Mail: ryan.mcCarthy@aecom.com

Project: **APG Lumbriculus**

TOXICITY TEST REPORT CERTIFICATION

The results reported relate only to the the samples submitted as received.

I certify under penalty of law that this document and all ATTACHMENTs were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of the person or persons who manage the system, or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations.

Executed on: 2/14/12
(Date)

(Authorized signature)
John Williams
Toxicity Laboratory Manager
Aquatec Biological Sciences, Inc.

Supportive Documentation

Chain-Of-Custody

Toxicity Test Methods

100.3 - Oligochaete, L. variegatus, Bioaccumulation Test for sediments

Standard Reference Toxicant Control Charts

Chain-Of-Custody

AECOM

CHAIN OF CUSTODY RECORD

Client/Project Name: AECOM/ESTCP- Canal Creek

Project Location: Aberdeen Proving Ground - Edgewood, MD

Project Number: 60133180

Field Logbook No.:

Sampler/Affiliation: M. Russell, D. Smith, N. Pinsker / AECOM

Chain of Custody Tape Nos.:

Signature:

Send Results/Report to: John.Bleiler@aecom.com

TAT: per terms

Container Type: P - Plastic, V - VOA, A - Amber Glass, O - Other, G - Clear Glass

Matrix Codes: W-Water, SD-Sediment, SO-Solid

Field Sample No./Identification	Date	Time	COMP	GRAB	Sample Container (Size/Mat'l)	Matrix	Preserv.	Field Filtered	PCB	PCB (treatment)	PCB (below treatment)	Organic Content	Moisture Content	pH	Macroinvertebrates	Bioaccumulation	Lab ID.	Remarks
APG-05/09-100411	10/4/2011	0920	X		2 gallon/P	SD	4°C	no								X		
APG-01/03-100411	10/4/2011	1025	X		2 gallon/P	SD	4°C	no								X		
APG-06/24-100411	10/4/2011	1030	X		2 gallon/P	SD	4°C	no								X		
APG-10/14-100411	10/4/2011	1240	X		2 gallon/P	SD	4°C	no								X		
APG-11/13-100411	10/4/2011	1435	X		2 gallon/P	SD	4°C	no								X		
APG-16/17-100411	10/4/2011	1450	X		2 gallon/P	SD	4°C	no								X		
APG-20/21-100411	10/4/2011	1540	X		2 gallon/P	SD	4°C	no								X		
APG-18/19-100411	10/4/2011	1610	X		2 gallon/P	SD	4°C	no								X		
APG-04/07-100411	10/4/2011	1645	X		2 gallon/P	SD	4°C	no								X		
APG-12/15-100511	10/5/2011	0915	X		2 gallon/P	SD	4°C	no								X		
APG-22/23-100511	10/5/2011	0920	X		2 gallon/P	SD	4°C	no								X		
APG-02/08-100511	10/5/2011	1030	X		2 gallon/P	SD	4°C	no								X		
APG-DUP-100511	10/5/2011	1030	X		2 gallon/P	SD	4°C	no								X		

Relinquished by: (Print Name)/(Affiliation)	Date / Time	Received by: (Print Name)/(Affiliation)
Michele Russell/AECOM Signature:	Date: 10/6/11 Time: 16:00	K. Downey 12/20/11 Signature: Karen Downey 10:30
Relinquished by: (Print Name)/(Affiliation) Signature:	Date: 12/20/11 Time: 10:30	Received by: (Print Name)/(Affiliation) Signature:
Relinquished by: (Print Name)/(Affiliation) Signature:	Date: Time:	Received by: (Print Name)/(Affiliation) Signature:

Analytical Laboratory (Destination):
AECOM Technical Services
c/o David A. Pillard, Ph.D., CSE
4303 W. Laporte Avenue
Fort Collins, CO 80521
(970) 416-0916 Ext. 310

Sample Shipped Via: UPS FedEx Courier Other

Temp Blank: Yes No

Sample APG-DUP-100511 was not received on 12/20/11

Sample APG-DUP-100511 was received on 12/21/11

Cooler #1 - 9.9°C
Cooler #2 - 9.5°C
Cooler #3 - 9.1°C
Cooler #4 - 7.8°C
Cooler #5 - 8.8°C opt
Cooler #6 - 9.6°C

AECOM

CHAIN OF CUSTODY RECORD

Page 1 of 1

Client/Project Name: AECOM/ESTCP- Canal Creek

Project Location: Aberdeen Proving Ground - Edgewood, MD

Project Number: 60133180

Field Logbook No.:

Sampler/Affiliation: M. Russell, D. Smith, N. Pinsker / AECOM

Chain of Custody Tape Nos.:

Signature:

Send Results/Report to: John.Bleiler@aecom.com

TAT: per terms

Container Type: P - Plastic, A - Amber Glass, G - Clear Glass, V - VOA, O - Other

Matrix Codes: W-Water, SD-Sediment, SO-Solid

Field Sample No./Identification	Date	Time	COMP	GRAB	Sample Container (Size/Mat'l)	Matrix	Preserv.	Field Filtered	PCB	PCB (treatment)	PCB (below treatment)	Organic Content	Moisture Content	pH	Macroinvertebrates	Bioaccumulation	Lab ID.	Remarks
APG-05/09-100411	10/4/2011	0920	X		2 gallon/P	SD	4°C	no								X		
APG-01/03-100411	10/4/2011	1025	X		2 gallon/P	SD	4°C	no								X		
APG-06/24-100411	10/4/2011	1030	X		2 gallon/P	SD	4°C	no								X		
APG-10/14-100411	10/4/2011	1240	X		2 gallon/P	SD	4°C	no								X		
APG-11/13-100411	10/4/2011	1435	X		2 gallon/P	SD	4°C	no								X		
APG-16/17-100411	10/4/2011	1450	X		2 gallon/P	SD	4°C	no								X		
APG-20/21-100411	10/4/2011	1540	X		2 gallon/P	SD	4°C	no								X		
APG-18/19-100411	10/4/2011	1610	X		2 gallon/P	SD	4°C	no								X		
APG-04/07-100411	10/4/2011	1645	X		2 gallon/P	SD	4°C	no								X		
APG-12/15-100511	10/5/2011	0915	X		2 gallon/P	SD	4°C	no								X		
APG-22/23-100511	10/5/2011	0920	X		2 gallon/P	SD	4°C	no								X		
APG-02/08-100511	10/5/2011	1030	X		2 gallon/P	SD	4°C	no								X		
APG-DUP-100511	10/5/2011	1030	X		2 gallon/P	SD	4°C	no								X		

Relinquished by: (Print Name)/(Affiliation)	Date/Time	Received by: (Print Name)/(Affiliation)
Michele Russell/AECOM Signature:	Date: 10/6/11 Time: 1600	JHOLT / TA BUR 12/20/11 1110 9.6°C Signature:
J. HOLT / TA BUR 12/20/11 1305 → Signature:	Date: Time:	Philip C Downey 12/20/11 Signature: Philip Downey 14:50
Relinquished by: (Print Name)/(Affiliation) Signature:	Date: Time:	Received by: (Print Name)/(Affiliation) Signature:

Analytical Laboratory (Destination):
AECOM Technical Services
c/o David A. Pillard, Ph.D., CSE
4303 W. Laporte Avenue
Fort Collins, CO 80521
(970) 416-0916 Ext. 310

Sample Shipped Via: UPS FedEx Courier Other

Temp Blank: Yes No

miss delivered to Test America

Copy

AECOM

CHAIN OF CUSTODY RECORD

Client/Project Name: AECOM/ESTCP- Canal Creek

Project Number: 60133180

Sampler/Affiliation: M. Russell, D. Smith, N. Pinsker / AECOM

Signature:

Project Location: Aberdeen Proving Ground - Edgewood, MD

Field Logbook No.:

Chain of Custody Tape Nos.:

Send Results/Report to: John.Bleiler@aecom.com

TAT: per terms

Container Type: P - Plastic, V - VOA, A - Amber Glass, O - Other, G - Clear Glass

Matrix Codes: W-Water, SD-Sediment, SO-Solid

Field Sample No./Identification	Date	Time	COMP	GRAB	Sample Container (Size/Mat'l)	Matrix	Preserv.	Field Filtered	PCB	PCB (treatment)	PCB (below treatment)	Organic Content	Moisture Content	pH	Macroinvertebrates	Bioaccumulation	Lab ID.	Remarks
APG-05/09-100411	10/4/2011	0920	X		2 gallon/P	SD	4°C	no								X		
APG-01/03-100411	10/4/2011	1025	X		2 gallon/P	SD	4°C	no								X		
APG-06/24-100411	10/4/2011	1030	X		2 gallon/P	SD	4°C	no								X		
APG-10/14-100411	10/4/2011	1240	X		2 gallon/P	SD	4°C	no								X		
APG-11/13-100411	10/4/2011	1435	X		2 gallon/P	SD	4°C	no								X		
APG-16/17-100411	10/4/2011	1450	X		2 gallon/P	SD	4°C	no								X		
APG-20/21-100411	10/4/2011	1540	X		2 gallon/P	SD	4°C	no								X		
APG-18/19-100411	10/4/2011	1610	X		2 gallon/P	SD	4°C	no								X		
APG-04/07-100411	10/4/2011	1645	X		2 gallon/P	SD	4°C	no								X		
APG-12/15-100511	10/5/2011	0915	X		2 gallon/P	SD	4°C	no								X		
APG-22/23-100511	10/5/2011	0920	X		2 gallon/P	SD	4°C	no								X		
APG-02/08-100511	10/5/2011	1030	X		2 gallon/P	SD	4°C	no								X		
APG-DUP-100511	10/5/2011	1030	X		2 gallon/P	SD	4°C	no								X		

Relinquished by: (Print Name)/(Affiliation)	Date/Time	Received by: (Print Name)/(Affiliation)
Michele Russell/AECOM Signature:	Date: 10/6/11 Time: 1600	Karen Downey 12/21/11 1100 Signature: Karen Downey
Relinquished by: (Print Name)/(Affiliation) Signature:	Date: 12/21/11 Time: 1100	Received by: (Print Name)/(Affiliation) Signature:
Relinquished by: (Print Name)/(Affiliation) Signature:	Date: Time:	Received by: (Print Name)/(Affiliation) Signature:

Analytical Laboratory (Destination):
AECOM Technical Services
c/o David A. Pillard, Ph.D., CSE
4303 W. Laporte Avenue
Fort Collins, CO 80521
(970) 416-0916 Ext. 310

Sample Shipped Via: UPS FedEx Courier Other

Temp Blank: Yes No

Cooler #1 10.6°C
Cooler #2 10.2°C
Cooler #3 10.4°C
Cooler #4 8.7°C
Cooler #5 9.9°C Copy
Cooler #6 9.0°C
Cooler #7 10.7°C

Aquatec Biological Sciences
Chain-of-Custody Record

273 Commerce Street
Williston, VT 05495
TEL: (802) 860-1638
FAX: (802) 658-3189

COMPANY INFORMATION

Name: Aquatec Biological Sciences, Inc.
Address: 273 Commerce Street
City/State/Zip: Williston, VT 05495
Telephone: (802) 860 - 1638
Facsimile:
Contact Name: Mr. John Williams

COMPANY'S PROJECT INFORMATION

Project Name: AECOM APG
Project Number: 12008
Sampler Name(s): PCD, JW, KD, KK, SR, JG
Client Code: AECOM/McCarthy

SHIPPING INFORMATION

Carrier: Fed Ex Ground
Shipping Number: 258892815004077
Date Shipped: 2/7/12
Hand Delivered: ____ Yes __X__ No

VOLUME/CONTAINER TYPE/ PRESERVATIVE

Frozen					
Amber Glass					
40 mL					

SAMPLE IDENTIFICATION	COLLECTION DATE	COLLECTION TIME	GRAB	COMPOSITE	MATRIX	ANALYSIS/REMARKS	NUMBER OF CONTAINERS					
42041 Control REP A	2/2/12	15:25		X	Tissue	Per Ryan McCarthy (AECOM)	1					
42041 Control REP B	2/2/12	16:10		X	Tissue	Per Ryan McCarthy (AECOM)	1					
42041 Control REP C	2/3/12	14:00		X	Tissue	Per Ryan McCarthy (AECOM)	1					
42042 APG-05/09-100411 REP A	2/2/12	17:00		X	Tissue	Per Ryan McCarthy (AECOM)	1					
42042 APG-05/09-100411 REP B	2/2/12	17:50		X	Tissue	Per Ryan McCarthy (AECOM)	1					
42042 APG-05/09-100411 REP C	2/2/12	17:35		X	Tissue	Per Ryan McCarthy (AECOM)	1					
42043 APG-01-03-100411 REP A	2/2/12	17:10		X	Tissue	Per Ryan McCarthy (AECOM)	1					
42043 APG-01-03-100411 REP B	2/2/12	17:25		X	Tissue	Per Ryan McCarthy (AECOM)	1					
42043 APG-01-03-100411 REP C	2/2/12	17:30		X	Tissue	Per Ryan McCarthy (AECOM)	1					
42044 APG-06/24-100411 REP A	2/2/12	17:20		X	Tissue	Per Ryan McCarthy (AECOM)	1					
42044 APG-06/24-100411 REP B	2/2/12	18:00		X	Tissue	Per Ryan McCarthy (AECOM)	1					
42044 APG-06/24-100411 REP C	2/2/12	18:10		X	Tissue	Per Ryan McCarthy (AECOM)	1					
42045 APG-10/14-100411 REP A	2/2/12	18:10		X	Tissue	Per Ryan McCarthy (AECOM)	1					
42045 APG-10/14-100411 REP B	2/2/12	18:15		X	Tissue	Per Ryan McCarthy (AECOM)	1					
42045 APG-10/14-100411 REP C	2/2/12	18:10		X	Tissue	Per Ryan McCarthy (AECOM)	1					

Relinquished by: (signature)	DATE	TIME	Received by: (signature)
	2/7/12	16:00	
Relinquished by: (signature)	DATE	TIME	Received by: (signature)
Relinquished by: (signature)	DATE	TIME	Received by: (signature)

NOTES TO Analytical Laboratory: Each composite consists of recovered organisms from that specific replicate. Collection time is the time organism cleaning & depuration was completed.

Temperature (°C) on delivery:

Aquatec Biological Sciences
Chain-of-Custody Record

273 Commerce Street
Williston, VT 05495
TEL: (802) 860-1638
FAX: (802) 658-3189

COMPANY INFORMATION	COMPANY'S PROJECT INFORMATION	SHIPPING INFORMATION	VOLUME/CONTAINER TYPE/ PRESERVATIVE
Name: Aquatec Biological Sciences, Inc.	Project Name: AECOM APG	Carrier: Fed Ex Ground	Frozen
Address: 273 Commerce Street	Project Number: 12008	Shipping Number: 258892815004077	Amber Glass
City/State/Zip: Williston, VT 05495	Sampler Name(s): PCD, JW, KD, KK, SR, JG	Date Shipped: 2/7/12	40 mL
Telephone: (802) 860 - 1638			
Facsimile:			
Contact Name: Mr. John Williams	Client Code: AECOM/McCarthy	Hand Delivered: ____ Yes X No	

SAMPLE IDENTIFICATION	COLLECTION DATE	COLLECTION TIME	GRAB	COMPOSITE	MATRIX	ANALYSIS/REMARKS	NUMBER OF CONTAINERS					
42046 APG-11/13-100411 REP A	2/2/12	18:20		X	Tissue	Per Ryan McCarthy (AECOM)	1					
42046 APG-11/13-100411 REP B	2/2/12	18:25		X	Tissue	Per Ryan McCarthy (AECOM)	1					
42046 APG-11/13-100411 REP C	2/2/12	18:25		X	Tissue	Per Ryan McCarthy (AECOM)	1					
42047 APG-16/17-100411 REP A	2/2/12	18:20		X	Tissue	Per Ryan McCarthy (AECOM)	1					
42047 APG-16/17-100411 REP B	2/2/12	18:30		X	Tissue	Per Ryan McCarthy (AECOM)	1					
42047 APG-16/17-100411 REP C	2/2/12	18:40		X	Tissue	Per Ryan McCarthy (AECOM)	1					
42048 APG-20/21-100411 REP A	2/3/12	14:15		X	Tissue	Per Ryan McCarthy (AECOM)	1					
42048 APG-20/21-100411 REP B	2/3/12	14:40		X	Tissue	Per Ryan McCarthy (AECOM)	1					
42048 APG-20/21-100411 REP C	2/3/12	15:25		X	Tissue	Per Ryan McCarthy (AECOM)	1					
42049 APG-18/19-100411 REP A	2/3/12	14:30		X	Tissue	Per Ryan McCarthy (AECOM)	1					
42049 APG-18/19-100411 REP B	2/3/12	14:50		X	Tissue	Per Ryan McCarthy (AECOM)	1					
42049 APG-18/19-100411 REP C	2/3/12	15:10		X	Tissue	Per Ryan McCarthy (AECOM)	1					
42050 APG-04/07-100411 REP A	2/3/12	15:00		X	Tissue	Per Ryan McCarthy (AECOM)	1					
42050 APG-04/07-100411 REP B	2/3/12	15:30		X	Tissue	Per Ryan McCarthy (AECOM)	1					
42050 APG-04/07-100411 REP C	2/3/12	16:00		X	Tissue	Per Ryan McCarthy (AECOM)	1					

Relinquished by: (signature)	DATE	TIME	Received by: (signature)
	2/7/12	16:00	
Relinquished by: (signature)	DATE	TIME	Received by: (signature)
Relinquished by: (signature)	DATE	TIME	Received by: (signature)

NOTES TO Analytical Laboratory: Each composite consists of recovered organisms from that specific replicate. Collection time is the time organism cleaning & depuration was completed.

Temperature (^oC) on delivery:

Aquatec Biological Sciences
Chain-of-Custody Record

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Williston, VT 05495
TEL: (802) 860-1638
FAX: (802) 658-3189

COMPANY INFORMATION	COMPANY'S PROJECT INFORMATION	SHIPPING INFORMATION	VOLUME/CONTAINER TYPE/ PRESERVATIVE
Name: Aquatec Biological Sciences, Inc.	Project Name: AECOM APG	Carrier: Fed Ex Ground	Frozen
Address: 273 Commerce Street	Project Number: 12008	Shipping Number: 258892815004077	Amber Glass
City/State/Zip: Williston, VT 05495	Sampler Name(s): PCD, JW, KD, KK, SR, JG	Date Shipped: 2/7/12	40 mL
Telephone: (802) 860 - 1638			
Facsimile:			
Contact Name: Mr. John Williams	Client Code: AECOM/McCarthy	Hand Delivered: ___ Yes _X_ No	

SAMPLE IDENTIFICATION	COLLECTION DATE	COLLECTION TIME	GRAB	COMPOSITE	MATRIX	ANALYSIS/REMARKS	NUMBER OF CONTAINERS
42051 APG-12/15-100511 REP A	2/3/12	15:40		X	Tissue	Per Ryan McCarthy (AECOM)	1
42051 APG-12/15-100511 REP B	2/3/12	16:05		X	Tissue	Per Ryan McCarthy (AECOM)	1
42051 APG-12/15-100511 REP C	2/3/12	16:20		X	Tissue	Per Ryan McCarthy (AECOM)	1
42052 APG-22/23-100511 REP A	2/3/12	16:30		X	Tissue	Per Ryan McCarthy (AECOM)	1
42052 APG-22/23-100511 REP B	2/3/12	17:08		X	Tissue	Per Ryan McCarthy (AECOM)	1
42052 APG-22/23-100511 REP C	2/3/12	17:14		X	Tissue	Per Ryan McCarthy (AECOM)	1
42053 APG-02/08-100511 REP A	2/3/12	16:12		X	Tissue	Per Ryan McCarthy (AECOM)	1
42053 APG-02/08-100511 REP B	2/3/12	16:25		X	Tissue	Per Ryan McCarthy (AECOM)	1
42053 APG-02/08-100511 REP C	2/3/12	16:45		X	Tissue	Per Ryan McCarthy (AECOM)	1
42054 Time 0 REP A	1/6/12	12:20		X	Tissue	Per Ryan McCarthy (AECOM)	1
42054 Time 0 REP B	1/6/12	12:20		X	Tissue	Per Ryan McCarthy (AECOM)	1
42054 Time 0 REP C	1/6/12	12:20		X	Tissue	Per Ryan McCarthy (AECOM)	1

Relinquished by: (signature)	DATE	TIME	Received by: (signature)
	2/7/12	16:00	
Relinquished by: (signature)	DATE	TIME	Received by: (signature)
Relinquished by: (signature)	DATE	TIME	Received by: (signature)

NOTES TO Analytical Laboratory: Each composite consists of recovered organisms from that specific replicate. Collection time is the time organism cleaning & depuration was completed.

Temperature (°C) on delivery:

FedEx

Shipment Receipt

Address Information

Ship to:	**Ship from:**
Scott Greenwood	Mr. John Williams
University of New Hampshire	Aquatec Biological Sciences
35 COLOVOS RD	273 Commerce Street
338 GREGG HALL	
DURHAM, NH	Williston, VT
03824-3521	05495
US	US
603 862-4334	8028601638

Shipping Information

Tracking number: 258892815004077
Ship date: 02/07/2012
Estimated shipping charges: 10.73

Package Information

Service type: FedEx Ground
Package type: Your Packaging
Number of packages: 1
Total weight: 40LBS
Declared value: 0.00USD
Special Services:
Pickup/Drop-off: Drop off package at FedEx location

Billing Information

Bill transportation to: MyAccount-917
Your reference:
P.O. no.:
Invoice no.:
Department no.:

Thank you for shipping online with Fedex ShipManager at fedex.com.

Please Note

FedEx will not be responsible for any claim in excess of $100 per package, whether the result of loss, damage, delay, non-delivery, misdelivery, or misinformation, unless you declare a higher value, pay an additional charge, document your actual loss and file a timely claim. Limitations found in the current FedEx Service Guide apply. Your right to recover from FedEx for any loss, including intrinsic value of the package, loss of sales, income interest, profit, attorney's fees, costs, and other forms of damage whether direct, incidental, consequential, or special is limited to the greater of $100 or the authorized declared value. Recovery cannot exceed actual documented loss. Maximum for items of extraordinary value is $500, e.g., jewelry, precious metals, negotiable instruments and other items listed in our Service Guide. Written claims must be filed within strict time limits; Consult the applicable FedEx Service Guide for details.
The estimated shipping charge may be different than the actual charges for your shipment. Differences may occur based on actual weight, dimensions, and other factors. Consult the applicable FedEx Service Guide or the FedEx Rate Sheets for details on how shipping charges are calculated.

Toxicity Test Methods

APG Lumbriculus

Project **12008**

1	Test type:	Whole-sediment toxicity test with renewal of overlying water
2	Temperature:	23 +/- 1C
3	Light quality:	Wide-spectrum fluorescent lights
4	Illuminance:	About 100 to 1000lux
5	Photoperiod:	16L:8D
6	Test chamber:	9L (2.5 gal) aquaria with water overflow port resulting in nominal 5.5 L volume
7	Sediment volume:	1L or more depending on total organic carbon (TOC)
8	Overlying water volume:	Approximately 4L
9	Renewal of overlying water:	2 volume additions/day; intermittent (e.g. 1 volume addition every 12h)
10	Age of organisms:	Adults
11	No. of organisms/chamber:	Ratio of TOC in sediment to organism dry weight should be no less than 50:1 Minimum of 1g/replicate. Preferably 5g/replicate.
12	No. of replicates/treatment:	3
13	Feeding:	None
14	Aeration:	Continuous light aeration
15	Overlying water:	Reconstituted Water
16	Test chamber cleaning:	Clean water delivery ports as needed
17	Overlying water quality:	Hardness, alkalinity, conductivity, pH, and ammonia at the beginning and end of a test. Temperature and dissolved oxygen daily.
18	Test duration:	28 days
19	Endpoints:	Bioaccumulation
20	Test acceptability:	Performance-based criteria (Table 13.4 EPA/600/R-99/064)

100.3 - Oligochaete, L. variegatus, Bioaccumulation Test for sediments

Project: 12008 , AECOM APG

Calculation of *Lumbriculus variegatus* loading

Sample #	Client ID	TOC Portion	Replicate Sediment Loading (g)	Replicate g TOC Available	Maximum Lv loading (g dry wt.)	Lv loading (g wet wt.)	Water factor	Theoretical Maximum Loading (g)	Actual Wet Loading (g) per Rep.	
								Control	7.3-7.75	
Note: TOC portion is based on average of the two stations (historic data)										
41931	**APG-05/09**	0.126	1284	162.17	3.24	24.95	1.33	33.18	**7.1-7.6**	
41932	**APG-01-03**	0.145	1425	206.91	4.14	31.83	1.33	42.34	**7.3-7.7**	
41933	**APG-06/24**	0.088	1195	105.16	2.10	16.18	1.33	21.52	**7.1-7.6**	
41934	**APG-10/14**	0.209	1093	228.16	4.56	35.10	1.33	46.69	**7.0-7.2**	
41935	**APG-11/13**	0.269	1256	337.49	6.75	51.92	1.33	69.06	**7.1-7.4**	
41936	**APG-16/17**	No data	1229	no data	no data	no data	no data	no data	**7.2-7.5**	**Extra g**
41937	**APG-20/21**	0.158	1390	219.69	4.39	33.80	1.33	44.95	**7.2-7.7**	**Rep A 2.0-2.5**
41938	**APG-18/19**	no data	1460	no data	no data	no data	no data	no data	**7.1-7.7**	**2.0-2.5**
41939	**APG-04/07**	0.092	1300	119.28	2.39	18.35	1.33	24.41	**7.3-7.3**	**2.0-2.5**
41940	**APG-12/15**	0.21	1320	279.91	5.60	43.06	1.33	57.27	**7.4-7.8**	**2.0-2.5**
41941	**APG-22/23**	0.21	1370	289.76	5.80	44.58	1.33	59.29	**7.5-7.8**	**2.0-2.5**
41942	**APG-02/08**	0.14	1300	183.82	3.68	28.28	1.33	37.61	**7.3-7.6**	**2.0-2.5**

Organic content, data from the 12/10 sampling event.
Samples are a homogenate of two locations, for instance APG-05/09 would be APG-05 and APG-9 below.

	Sample	TOC	Sample	TOC	Avg. TOC
41931:	APG-5	10.1%	APG-9	15.1%	**12.6%**
41932:	APG-1	22.3%	APG-3	6.7%	**14.5%**
41933:	APG-6	6.3%	APG-24	11.3%	**8.8%**
41934:	APG-10	22.9%	APG-14	18.8%	**20.9%**
41935:	APG-11	31.1%	APG-13rep	22.6%	**26.9%**
41936:	APG-16	No data	APG-17	No data	**No Data**
41937:	APG-20	9.3%	APG-21	22.3%	**15.8%**
41938:	APG18	No data	APG-19	No data	**No Data**
41939:	APG-4	13.5%	APG-7	4.9%	**9.2%**
41940:	APG-12rep	26.5%	APG-15	15.9%	**21.2%**
41941:	APG-22	16.4%	APG-23	25.9%	**21.2%**
41942:	APG-2	18.8%	APG-8	9.5%	**14.1%**

Aquatec Biological Sciences, Inc.
273 Commerce Street
Williston, VT 05495

Reviewed by: σ
Review Date: 2/8/12

Project: APG Lumbriculus

100.3 Oligochaete, L. variegatus, Bioaccumulation Test for sediments

Species: *Lumbriculus variegatus* Reference: EPA/600/R-99/064 SOP: TOX3-006

Lumbriculus variegatus Initial Biomass (g)

Sample Number	Sample Identification	Rep A	Rep B	Rep C	Initials / Date
41930	Control	7.38	7.75	7.34 1/6/12	J 1/5/12
41931	APG-05/09-100411	7.1	7.31	7.55	16:25
41932	APG-01-03-100411	7.26	7.72	7.51	
41933	APG-06/24-100411	7.20	7.65	7.10	
41934	APG-10/14-100411	7.15	7.03	7.18	
41935	APG-11/13-100411	7.20	~~7.20~~ 7.13 J	7.42	
41936	APG-16/17-100411	7.25	7.25	7.54	
41937	APG-20/21-100411	7.39*	7.70	7.18	J 1/6/12
41938	APG-18/19-100411	7.68*	7.33	7.14	11:58
41939	APG-04/07-100411	7.34*	~~7.32~~ 7.26 J	7.32	
41940	APG-12/15-100511	7.82*	7.63	7.40	
41941	APG-22/23-100511	7.77*	7.52	7.6	
41942	APG-02/08-100511	7.62*	7.37	7.32	

Note: 41930 Rep C will be started on 1/6/12 J

Sample 42054 + 1.88g = 7.24g

Time 0 A 5.36 g
Time 0 B 5.44 g
Time 0 C 5.64 g

1/6/11 12:00 (12:20 FROZEN)

Time 0 organisms to frozen 1/6/12 12:20J

DRY WT
PAN WT. 2.27g
Pan + Lv 3.27
(1.0 g WORMS)
IN Oven 12:10 1/6/12

* Added 2-2.5g additional worms to A Reps due to organisms being available. (Nominal 9-10 g total)

Aquatec Biological Sciences, Inc.
Reviewed by: J Date: 2/6/12

SDG: 12957
Project: 12008

Aquatec Biological Sciences, Inc.

273 Commerce Street
Williston, VT 05495
Tel: (802) 860 - 1638 Fax: (802) 658 - 3189

AECOM
1000 Elm Street
8th Floor
Manchester, NH 03101

Tel: (978) 905-2312
Fax: (603) 622-8480

E-Mail: ryan.mcCarthy@aecom.com

BIOACCUMULATION TEST END

100.3 Oligochaete, L. variegatus, Bioaccumulation Test for sediments

Depuration Start Date: 2/2/12, End Date: 2/2/12.

Sediment Sample # / ID:		Rep	Depuration (Time/Init.) Start	End	Post Depuration Rinse	Jar + Cap Weight (g)	(1) Jar + Cap + Organisms (g)	Tissue Sample # / ID:	Rep
41930 / Control	2/2/12	A	07:00 JT	15:25	✓	30.26	35.71 ~~31.92~~	42041 / Control - T	A
41930 / Control	2/2/12	B	07:30 JT	16:10	✓	30.22	35.00	42041 / Control - T	B
41930 / Control	2/3/12	C	~~06:45~~ JT	—14:00	✓	30.80	36.09	42041 / Control - T	C
41931 / APG-05/09-100411		A	0730 RR	17:00	✓	31.18	35.51	42042 / APG-05/09-100411 - T	A
41931 / APG-05/09-100411		B	0800 RR	17:50	✓	JT 30.7~~2~~1	35.18	42042 / APG-05/09-100411 - T	B
41931 / APG-05/09-100411		C	0830 RR	17:35	✓	30.16	34.67	42042 / APG-05/09-100411 - T	C
41932 / APG-01-03-100411		A	0830 SR	17:10	✓	30.07	33.54	42043 / APG-01-03-100411 - T	A
41932 / APG-01-03-100411		B	0920 SR	17:25	✓	30.27	34.37	42043 / APG-01-03-100411 - T	B
41932 / APG-01-03-100411		C	0950 SR	17:30	✓	30.34	33.99	42043 / APG-01-03-100411 - T	C
41933 / APG-06/24-100411		A	JT 08:50	17:20	✓	30.38	34.59	42044 / APG-06/24-100411 - T	A
41933 / APG-06/24-100411		B	JT 09:20	18:00	✓	30.93	34.79	42044 / APG-06/24-100411 - T	B
41933 / APG-06/24-100411		C	JT 09:50	18:10	✓	30.45	34.23	42044 / APG-06/24-100411 - T	C
41934 / APG-10/14-100411		A	P 09:05	18:10	✓	30.60	35.58	42045 / APG-10/14-100411 - T	A
41934 / APG-10/14-100411		B	P 09:50	18:15	✓	JT 30.6~~7~~6	35.55	42045 / APG-10/14-100411 - T	B
41934 / APG-10/14-100411		C	P 10:50	18:10	✓	30.85	37.41	42045 / APG-10/14-100411 - T	C

(1) 41930 A corrected wt. with cap included JT

22

Aquatec Biological Sciences, Inc.
Reviewed by: JT Date: 2/6/12.

SDG: 12957
Project: 12008

BIOACCUMULATION TEST END

100.3 Oligochaete, L. variegatus, Bioaccumulation Test for sediments

Depuration Start Date: 2 / 2 / 12, End Date: 2 / ~~12~~ 2 / 12.

Sediment Sample # / ID:	Rep	Depuration (Time/Init.) Start	End	Post Depuration Rinse	Jar + Cap Weight (g)	Jar + Cap + Organisms (g)	Tissue Sample # / ID:	Rep
41935 / APG-11/13-100411	A	1045 SR	18:20	✓	29.99	34.07	42046 / APG-11/13-100411 - T	A
41935 / APG-11/13-100411	B	1125 SR	18:25	✓	30.28	34.79	42046 / APG-11/13-100411 - T	B
41935 / APG-11/13-100411	C	1205 SR	18:25	✓	30.5~~7~~4	35.07	42046 / APG-11/13-100411 - T	C
41936 / APG-16/17-100411	A	10:45	18:20	✓	30.10	38.28	42047 / APG-16/17-100411 - T	A
41936 / APG-16/17-100411	B	11:30	18:30	✓	30.01	37.11	42047 / APG-16/17-100411 - T	B
41936 / APG-16/17-100411	C	12:10	18:40	✓	30.2~~9~~8	37.95	42047 / APG-16/17-100411 - T	C
							Time 0 (Lv)	A
							Time 0 (Lv) See following	B
							Time 0 (Lv) data sheets.	C

2/2/12 18:55
Tissues ~~ft~~ in 40mL vials
TRANSFERRED TO FREEZER

23

Aquatec Biological Sciences, Inc.
Reviewed by: ______ Date: 2/6/12

SDG: 12957
Project: 12008

Aquatec Biological Sciences, Inc.
273 Commerce Street
Williston, VT 05495
Tel: (802) 860 - 1638 Fax: (802) 658 - 3189

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1000 Elm Street
8th Floor
Manchester, NH 03101

Tel: (978) 905-2312
Fax: (603) 622-8480

E-Mail: ryan.mcCarthy@aecom.com

BIOACCUMULATION TEST END

100.3 Oligochaete, L. variegatus, Bioaccumulation Test for sediments

Depuration Start Date: 2 / 3 / 12, End Date: 2 / 3 / 12.

Sediment Sample # / ID:	Rep	Depuration (Time/Init.) Start	Depuration (Time/Init.) End	Post Depuration Rinse	Jar + Cap Weight (g)	Jar + Cap + Organisms (g)	Tissue Sample # / ID:	Rep
41937 / APG-20/21-100411	A	0650 SR	~~12~~ 14:15	✓	30.66	37.66	42048 / APG-20/21-100411 - T	A
41937 / APG-20/21-100411	B	0720 SR	14:40	✓	31.00	38.63	42048 / APG-20/21-100411 - T	B
41937 / APG-20/21-100411	C	0745 SR	15:25	✓	30.67	37.10	42048 / APG-20/21-100411 - T	C
41938 / APG-18/19-100411	A	0655 ML	14:30	✓	30.52	38.88	42049 / APG-18/19-100411 - T	A
41938 / APG-18/19-100411	B	0720 ML	14:50	✓	31.26	36.77	42049 / APG-18/19-100411 - T	B
41938 / APG-18/19-100411	C	0745 ML	15:10	✓	30.23	35.90	42049 / APG-18/19-100411 - T	C
41939 / APG-04/07-100411	A	07:35 S	15:00	✓	30.35	37.39	42050 / APG-04/07-100411 - T	A
41939 / APG-04/07-100411	B	08:00 S	15:30	✓	30.32	35.74	42050 / APG-04/07-100411 - T	B
41939 / APG-04/07-100411	C	08:30 S	16:00	✓	31.15	38.15	42050 / APG-04/07-100411 - T	C
41940 / APG-12/15-100511	A	0820 SR	15:40	✓	30.04	40.94	42051 / APG-12/15-100511 - T	A
41940 / APG-12/15-100511	B	0850 SR	16:05	✓	30.54	38.98	42051 / APG-12/15-100511 - T	B
41940 / APG-12/15-100511	C	0925 SR	16:20	✓	30.44	38.92	42051 / APG-12/15-100511 - T	C
41941 / APG-22/23-100511	A	P 10:00	16:30	✓	30.60	35.36	42052 / APG-22/23-100511 - T	A
41941 / APG-22/23-100511	B	P 10:55	17:08	✓	30.56	34.17	42052 / APG-22/23-100511 - T	B
41941 / APG-22/23-100511	C	10:55 S	17:14	✓	31.11	35.56	42052 / APG-22/23-100511 - T	C

Aquatec Biological Sciences, Inc.
Reviewed by: S Date: 2/6/12.

SDG: 12957
Project: 12008

BIOACCUMULATION TEST END

100.3 Oligochaete, L. variegatus, Bioaccumulation Test for sediments

Depuration Start Date: 2/3/12, End Date: 2/3/12.

Sediment Sample # / ID:	Rep	Depuration (Time/Init.) Start	Depuration (Time/Init.) End	Post Depuration Rinse	Jar + Cap Weight (g)	Jar + Cap + Organisms (g)	Tissue Sample # / ID:	Rep
41942 / APG-02/08-100511	A	09:10	16:12	✓	~~30.68~~ 30.78	35.68	42053 / APG-02/08-100511 - T	A
41942 / APG-02/08-100511	B	09:50	16:25	✓	~~30.51~~ 31.07	35.28	42053 / APG-02/08-100511 - T	B
41942 / APG-02/08-100511	C	10:25	16:45	✓	30.16	34.08	42053 / APG-02/08-100511 - T	C
					30.689	5.36g	Time 0 (Lv) 1/6/11 12:20	A
					30.51	5.44g	Time 0 (Lv)	B
					30.27	5.64g	Time 0 (Lv)	C

All tissue samples from 2/3/12 transferred to freezer 17:20 2/3/12

Sample 42311 Time 0

Time 0 Tissue wt

Aquatec Biological Sciences, Inc.
Reviewed by: ______ Date: 2/6/12.

SDG: 12957
Project: 12008

Project: 12008 , AECOM APG
***Lumbricculus variegatus* wet to dry weight ratio**

Wet:dry weight ratio *Lumbriculus variegatus* 01/06/12

	Pan (g)	Pan + wet Lv	Pan + dry Lv	Org dry wt. (g)	Org wet wt. (g)
	2.27	3.27	2.40	0.13	1
Date:	1/6/2012	1/6/2012	1/7/2012		
Time:	12:10	12:10 (in oven)	12:05 (out of oven)		
Oven temperature:					
Initials:	JW	JW	JG		
	Wet weight to dry weight ratio.		**0.13**		

Aquatec Biological Sciences, Inc.
273 Commerce Street
Williston, VT 05495

Reviewed by: CJ
Review Date: 2/6/12

Aquatic Research Organisms

DATA SHEET

I. Organism History

Species: Lumbriculus variegatus

Source: Lab reared ✓ Hatchery reared ____ Field collected ____

Hatch date: 10-11 Receipt date: ____

Lot number: 100011LV✓ Strain: ____

Brood origination: Rochester NY

II. Water Quality

Temperature: 20 °C Salinity: <1 ppt D.O. — ppm

pH: 7.2 su Hardness: — ppm Alkalinity: — ppm

III. Culture Conditions

Freshwater ✓ Saltwater ____ Other ____

Recirculating ____ Flow through ✓ Static renewal ____

DIET: Flake food ____ Phytoplankton ____ Trout chow ✓

Artemia ____ Rotifers ____ YCT ____ Other ____

Prophylactic treatments: ____

Comments: ____

Received: 1-5-2012
Temp = 10.5°C
pH = 6.9
D.O. = 14.2
Cond. = 714
Added Sed. Recon water.
JG

IV. Shipping Information

Client: AquaTech VT # of Organisms: 300+ grams

Carrier: FedX Date shipped: 1-4-12

Biologist: Mark Rosengrant

1-6-12 JG
Temp. = 21.5°C
pH = 7.9
D.O. = 6.7
Cond. = 517

PO BOX 1271 HAMPTON NH 03843-1271 (603) 926-1650 AROFISH@AOL.COM

Project: APG Lumbriculus

100.3 Oligochaete, L. variegatus, Bioaccumulation Test for sediments

Species: *Lumbriculus variegatus* Reference: EPA/600/R-99/064 SOP: TOX3-006

CHEMISTRY DATA: Chemical analysis Date/Initials are noted on last page of Days 0 - 15 chemistry data sheets

Sample	Analysis	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
41930	pH	7.9						7.8	①						7.3		
Control	DO	7.9	8.0	8.0	8.8	8.6	8.8	8.1	8.9	8.0	8.3	8.2	9.3	9.2	8.2	8.3	8.6
	Cond.	346					~~36~~	367	8.4						374		
41931	pH	7.8						7.9							7.6		
APG-05/09-	DO	7.8	8.1	8.0	8.9	9.6	9.2	8.1	9.1	8.2	8.4	8.6	9.5	9.3	8.5	8.5	9.0
100411	Cond.	397						407	8.6						398		
41932	pH	7.5						7.8							7.7		
APG-01-03-	DO	7.7	8.0	8.1	8.7	9.2	9.0	7.8	9.1	8.2	8.4	8.3	9.3	9.2	7.9	8.6	9.0
100411	Cond.	384						404	8.5						392		
41933	pH	7.5						7.9							7.9		
APG-06/24-	DO	7.4	8.0	8.1	9.0	9.6	9.4	8.1	9.5	8.3	8.5	8.6	9.7	9.5	8.4	8.5	8.8
100411	Cond.	389						390	8.9						409		
41934	pH	7.8						7.6							7.8		
APG-10/14-	DO	7.8	8.2	8.1	8.6	9.3	8.9	7.7	9.0	8.0	8.4	8.4	8.4	7.9	7.0	8.3	8.2
100411	Cond.	398						389	8.7						363		
41935	pH	7.7						7.7							7.7		
APG-11/13-	DO	7.9	8.1	8.0	8.9	9.4	9.2	8.0	9.3	8.3	8.5	8.4	9.5	9.4	8.1	8.6	8.7
100411	Cond.	392						396	9.1						380		
41936	pH	7.7						7.7							7.6		
APG-16/17-	DO	7.6	8.0	7.9	8.3	9.0	8.4	7.6	8.4	7.8	8.0	8.5	8.7	8.3	7.2	7.8	7.8
100411	Cond.	427						402	8.2						393		
2012	Date	1/5	1/6	1/7	1/8	1/9	1/10	1/11	1/12	1/13	1/14	1/15	1/16	1/17	1/18	1/19	1/20
	Initials	JG	JG	JG	KK	[illegible]	J	[illegible]	[illegible]	JG	JG	KK	RR	[illegible]	KK	JG	[illegible]

① Recalibrated D.O. meter. Values in cond. box are re-measured D.O.s after recalibration [illegible] 1/12/12

Aquatec Biological Sciences, Inc.
Reviewed by: [illegible] Date: 2/6/12

SDG: 12957
Project: 12008

Project: APG Lumbriculus

100.3 Oligochaete, L. variegatus, Bioaccumulation Test for sediments

Species: *Lumbriculus variegatus* Reference: EPA/600/R-99/064 SOP: TOX3-006

CHEMISTRY DATA: Chemical analysis Date/Initials are noted on last page of Days 16 - 31 chemistry data sheets

Sample	Analysis	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
41930	pH						7.5						7.9				
Control	DO	8.1	8.7	8.8	8.5	8.6	8.2	8.1	8.4	8.8	8.9	8.5	8.4	9.2	9.3		
	Cond.						367						370				
41931	pH						7.8						8.0				
APG-05/09-	DO	7.8	9.1	8.9	8.5	8.4	8.3	8.2	8.4	8.9	9.0	8.5	8.3	9.4			
100411	Cond.						411						392				
41932	pH						7.8						7.9				
APG-01-03-	DO	8.0	8.8	8.9	8.0	8.2	8.1	7.9	8.2	8.9	9.0	8.3	8.2	9.3			
100411	Cond.						380						381				
41933	pH						7.8						8.1				
APG-06/24-	DO	8.0	9.3	9.3	8.4	8.5	8.4	8.3	8.3	9.1	9.1	8.5	8.2	9.6			
100411	Cond.						385						393				
41934	pH						7.9						7.9				
APG-10/14-	DO	7.5	7.8	8.6	7.9	8.1	8.0	7.9	8.1	8.5	9.0	8.3	8.0	9.2			
100411	Cond.						358						366				
41935	pH						7.8						7.9				
APG-11/13-	DO	7.8	8.8	8.9	8.2	8.5	8.2	8.2	8.3	8.9	8.9	8.4	8.2	9.6			
100411	Cond.						371						373				
41936	pH						7.7						7.8				
APG-16/17-	DO	7.4	8.0	7.9	7.5	7.7	7.6	7.5	7.8	8.4	8.6	8.2	7.7	9.1			
100411	Cond.						377						374				
2012	Date	1/21	1/22	1/23	1/24	1/25	1/26	1/27	1/28	1/29	1/30	1/31	2/1	2/2	2/3		
	Initials	JG	KK	J	JG	JG	JG	JG	JG	KK	J	JG	JG	KK	KK		

Aquatec Biological Sciences, Inc.

Reviewed by: J Date: 2/6/12

29

SDG: 12957

Project: 120^

Project: APG Lumbriculus

100.3 Oligochaete, L. variegatus, Bioaccumulation Test for sediments

Species: *Lumbriculus variegatus* Reference: EPA/600/R-99/064 SOP: TOX3-006

CHEMISTRY DATA: Chemical analysis Date/Initials are noted on last page of Days 0 - 15 chemistry data sheets

Sample	Analysis	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
41937	pH	7.8					7.7	(1)						7.6			
APG-20/21-	DO	7.9	8.1	8.5	9.2	8.9	7.9	8.9	8.4	8.3	8.8	8.9	8.8	7.6	7.9	8.1	7.7
100411	Cond.	456				418	→	8.5						411			
41938	pH	7.9					7.8							7.7			
APG-18/19-	DO	8.0	8.1	8.6	9.2	8.9	7.8	9.1	8.2	8.5	8.9	9.1	9.0	7.7	8.1	8.7	7.5
100411	Cond.	421				400	→	8.6						391			
41939	pH	7.7					7.7							7.7			
APG-04/07-	DO	7.6	7.9	8.4	9.0	8.6	7.6	8.8	7.8	8.0	8.4	8.6	8.5	7.2	7.8	7.9	7.4
100411	Cond.	400				397	→	8.4						384			
41940	pH	7.7					7.6							7.6			
APG-12/15-	DO	7.5	7.7	8.6	8.4	7.9	6.9	8.0	7.6	7.5	8.7	7.9	7.8	6.8	7.6	7.5	7.2
100511	Cond.	427				418	→	7.7						408			
41941	pH	7.6					7.7							7.7			
APG-22/23-	DO	7.6	7.9	8.4	8.9	8.7	7.8	9.3	8.2	8.4	8.3	9.1	9.4	7.9	8.4	8.6	7.8
100511	Cond.	381				377	→	8.9						374			
41942	pH	7.6					7.7							7.7			
APG-02/08-	DO	7.5	7.9	8.7	9.3	8.8	8.0	9.5	8.3	8.5	8.9	9.2	9.3	7.8	8.5	8.6	8.0
100511	Cond.	403				397	→	9.2						383			
2012	Date	1/6	1/7	1/8	1/9	1/10	1/11	1/12	1/13	1/14	1/15	1/16	1/17	1/18	1/19	1/20	1/21
	Initials	JG	JG	KK	[illegible]	[illegible]	[illegible]	[illegible]	JG	JG	KK	KK	[illegible]	KK	JG	[illegible]	JG

(1) Recalibrated D.O. meter. Values in Cond. box are re-measured D.O.s after recalibration. [illegible] 1/12/12

Project: APG Lumbriculus

100.3 Oligochaete, L. variegatus, Bioaccumulation Test for sediments

Species: *Lumbriculus variegatus* Reference: EPA/600/R-99/064 SOP: TOX3-006

CHEMISTRY DATA: Chemical analysis Date/Initials are noted on last page of Days 16 - 31 chemistry data sheets

Sample	Analysis	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
41937	pH					7.7						7.8					
APG-20/21-	DO	8.3	8.2	7.5	8.0	8.2	7.5	8.0	8.4	8.7	8.2	8.0	8.9	8.8			
100411	Cond.					382						395					
41938	pH					7.7						7.8					
APG-18/19-	DO	8.4	8.4	7.6	7.8	7.7	7.6	7.7	8.2	8.9	8.3	7.7	8.9	9.0			
100411	Cond.					374						382					
41939	pH					7.7						7.7					
APG-04/07-	DO	8.0	8.2	7.4	7.9	7.5	7.6	7.8	8.4	8.6	8.3	7.7	9.0	9.1			
100411	Cond.					371						377					
41940	pH					7.6						7.7					
APG-12/15-	DO	7.0	7.5	7.4	7.6	7.4	7.6	7.5	8.0	8.6	7.9	7.5	8.8	8.4			
100511	Cond.					394						390					
41941	pH					7.7						7.9					
APG-22/23-	DO	7.8	8.7	8.1	8.4	~~7~~8.3	7.7	8.1	8.9	8.9	8.5	7.9	9.5	9.4			
100511	Cond.					367						368					
41942	pH					7.7						7.8					
APG-02/08-	DO	8.9	8.6	7.8	8.2	8.1	7.9	8.1	8.8	9.1	8.4	7.9	9.3	9.3			
100511	Cond.					369						373					
2012	Date	1/22	1/23	1/24	1/25	1/26	1/27	1/28	1/29	1/30	1/31	2/1	2/2	2/3			
	Initials	KR	J	JG	JG	JG	JG	JG	KK	J	JG	JG	KK	KK			

Aquatec Biological Sciences, Inc. 31

Reviewed by: J Date: 2/6/12

SDG: 12957

Project: 12008

Aquatec Biological Sciences
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Project: 12008

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Manchester, NH 03101

Tel: (978) 905-2312
Fax: (603) 622-8480
E-Mail: ryan.mcCarthy@aec

ALKALINITY AND HARDNESS

Sample ID:			Sample Date:	Alkalinity: (mg/L)	Hardness: (mg/L)
41930	Control	Lv Day 0	1/5/2012	52.0	86.0
41931	APG-05/09-100411	Lv Day 0	1/5/2012	64.0	98.0
41932	APG-01-03-100411	Lv Day 0	1/5/2012	60.0	92.0
41933	APG-06/24-100411	Lv Day 0	1/5/2012	56.0	86.0
41934	APG-10/14-100411	Lv Day 0	1/5/2012	52.0	82.0
41935	APG-11/13-100411	Lv Day 0	1/5/2012	52.0	84.0
41936	APG-16/17-100411	Lv Day 0	1/5/2012	60.0	92.0
41937	APG-20/21-100411	Lv Day 0	1/6/2012	76.0	INF
41938	APG-18/19-100411	Lv Day 0	1/6/2012	68.0	100.0
41939	APG-04/07-100411	Lv Day 0	1/6/2012	64.0	96.0
41940	APG-12/15-100511	Lv Day 0	1/6/2012	72.0	100.0
41941	APG-22/23-100511	Lv Day 0	1/6/2012	56.0	INF
41942	APG-02/08-100511	Lv Day 0	1/6/2012	64.0	98.0
41937	APG-20/21-100411	Lv Day 26	2/1/2012	52.0	104.0
41938	APG-18/19-100411	Lv Day 26	2/1/2012	48.0	96.0
41939	APG-04/07-100411	Lv Day 26	2/1/2012	52.0	94.0
41940	APG-12/15-100511	Lv Day 26	2/1/2012	56.0	100.0
41941	APG-22/23-100511	Lv Day 26	2/1/2012	48.0	88.0
41942	APG-02/08-100511	Lv Day 26	2/1/2012	56.0	96.0
41930	Control	Lv Day 27	2/1/2012	56.0	94.0
41931	APG-05/09-100411	Lv Day 27	2/1/2012	56.0	100.0
41932	APG-01-03-100411	Lv Day 27	2/1/2012	56.0	94.0
41933	APG-06/24-100411	Lv Day 27	2/1/2012	64.0	102.0
41934	APG-10/14-100411	Lv Day 27	2/1/2012	40.0	84.0
41935	APG-11/13-100411	Lv Day 27	2/1/2012	56.0	92.0
41936	APG-16/17-100411	Lv Day 27	2/1/2012	44.0	92.0

.INF: Interference. The color endpoint was reached immediately.

Reviewed by: [signature] Date: 2/14/12

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SDG: 12957
Project: 12008

AMMONIA ANALYSIS REPORT

Project: APG Lumbriculus

100.3 **Oligochaete, L. variegatus, Bioaccumulation Test for sediments**

Species: *Lumbriculus variegatus* Reference: EPA/600/R-99/064 SOP: TOX3-006

Sample	Pore Water (mg/L) 1/4/2012	Overlying Water (mg/L) 1/5/2012	Overlying Water (mg/L) 2/1/2012
41930 - **Control**	1.7	0.1	0.2
41931 - **APG-05/09-100411**	2.5	0.3	0.1 BD
41932 - **APG-01-03-100411**	2.6	0.4	0.1 BD
41933 - **APG-06/24-100411**	1.9	0.2	0.1 BD
41934 - **APG-10/14-100411**	3.7	0.5	0.1 BD
41935 - **APG-11/13-100411**	2.2	0.3	0.1 BD
41936 - **APG-16/17-100411**	1.4	0.3	0.1 BD

BD- Indicates a concentration value below the reporting limit (<0.1).

Reviewed by: GJ Date: 2/8/12

Wednesday, February 08, 2012

Aquatec Biological Sciences, Inc.
273 Commerce Street
Williston, VT 05495
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SDG: 12957
Project: 12008

AMMONIA ANALYSIS REPORT

Project: APG Lumbriculus

100.3 **Oligochaete, L. variegatus, Bioaccumulation Test for sediments**

Species: *Lumbriculus variegatus* Reference: EPA/600/R-99/064 SOP: TOX3-006

Sample	Pore Water (mg/L)	Overlying Water (mg/L)	
	1/4/2012	1/6/2012	2/1/2012
41937 - **APG-20/21-100411**	1.1	0.2	0.1 BD
41938 - **APG-18/19-100411**	2.2	0.3	0.1 BD
41939 - **APG-04/07-100411**	2.8	0.5	0.1 BD
41940 - **APG-12/15-100511**	2.7	0.6	0.2
41941 - **APG-22/23-100511**	2.2	0.5	0.1 BD
41942 - **APG-02/08-100511**	2.4	0.4	0.1 BD

BD- Indicates a concentration value below the reporting limit (<0.1).

Reviewed by: O Date: 2/8/12

Wednesday, February 08, 2012

Temperature Data

Group 1	Date	Cart 1	Cart 2	Cart 3	Cart 1	Cart 2	Cart 3
		Beginning of Day			End of Day		
Day 0	1/5/2012				23	22.8	23.9
Day 1	1/6/2012	23.6	23	23.4	23.2	22.9	22.9
Day 2	1/7/2012	23.5	23.3	23.5	23.1	22.8	23
Day 3	1/8/2012	23.5	23.3	23.5	23.4	23.3	23.4
Day 4	1/9/2012	23.6	23.3	23.7	23.4	23.2	23.7
Day 5	1/10/2012	23.8	23.2	23.6	23.6	23.3	23.8
Day 6	1/11/2012	23.8	23.3	23.9	23.3	23.1	23.6
Day 7	1/12/2012	23.7	23.1	23.8	23.7	23.4	23.9
Day 8	1/13/2012	23.6	23.3	23.7	23.7	23.3	23.8
Day 9	1/14/2012	23.6	23.2	23.8	23.5	23.1	23.6
Day 10	1/15/2012	22.9	22.9	23.3	23.2	23.1	23.6
Day 11	1/16/2012	23.1	23	23.5	23.3	23.1	23.6
Day 12	1/17/2012	23.8	23.2	24	23.7	23.3	23.8
Day 13	1/18/2012	23.3	23.1	23.4	23.4	23.1	23.3
Day 14	1/19/2012	23.4	22.8	23.1	23.5	23.1	23.3
Day 15	1/20/2012	23.9	23.3	23.5	23.3	23	23
Day 16	1/21/2012	23.4	23	23.2	23.3	22.9	23
Day 17	1/22/2012	23.4	23	23	23.4	23.1	23.1
Day 18	1/23/2012	23.8	23.3	23.4	23.6	23.2	23.2
Day 19	1/24/2012	23.6	23.4	23.3	23.6	23.3	23.2
Day 20	1/25/2012	23.6	23.2	23.1	23.6	23.4	23.3
Day 21	1/26/2012	23.6	23	23.2	23.2	22.8	22.9
Day 22	1/27/2012	23.6	23.2	23.3	24.1	23.3	23.5
Day 23	1/28/2012	23.1	23.1	23.2	22.8	22.7	23
Day 24	1/29/2012	22.9	23.1	23.1	22.8	23.1	23.1
Day 25	1/30/2012	23.1	23.2	23.3	23.1	23.2	23.3
Day 26	1/31/2012	23	23.1	23.1	23	23.1	23.1
Day 27	2/1/2012	23.1	23.1	23.3	23	23.1	23.2
Day 28	2/2/2012	22.8	23.1	23.1			

Minimum (°C):	**22.8**	**22.8**	**23**	**22.8**	**22.7**	**22.9**
Maximum (°C):	**23.9**	**23.4**	**24**	**24.1**	**23.4**	**23.9**
Average (°C):	**23.4**	**23.1**	**23.4**	**23.4**	**23.1**	**23.4**

Reviewed by: JT
Review date: 2/13/12

Project: 12008
AECOM APG

Temperature Data

SDG 12957
Lumbriculus variegatus bioaccumulation

Group 2	Date	Cart 4	Cart 5	Cart 6	Cart 4	Cart 5	Cart 6
		Beginning of Day			End of Day		
Day 0	1/6/2012				22.4	22.4	22.7
Day 1	1/7/2012	23	22.7	23.2	22.4	22.5	22.9
Day 2	1/8/2012	23.3	23	23.4	23	22.8	23.1
Day 3	1/9/2012	23	22.8	23	23	22.9	23.5
Day 4	1/10/2012	23	22.9	23.4	23	22.8	23.2
Day 5	1/11/2012	22.9	23.1	23.1	22.9	22.8	23.1
Day 6	1/12/2012	23	22.9	23.2	23.1	23	23.3
Day 7	1/13/2012	23.1	23	23.4	23.1	23.1	23.3
Day 8	1/14/2012	22.9	22.9	23.3	22.9	23	23.3
Day 9	1/15/2012	22.6	22.5	22.9	22.9	22.6	23.1
Day 10	1/16/2012	22.6	22.6	22.9	22.9	22.8	23.2
Day 11	1/17/2012	23	22.8	23.1	23	23	23.2
Day 12	1/18/2012	22.8	22.9	23.1	22.7	22.8	23.1
Day 13	1/19/2012	22.7	22.8	23.2	22.9	23.1	23.3
Day 14	1/20/2012	22.8	23	23	22.5	22.6	22.5
Day 15	1/21/2012	22.8	23	23.4	22.7	23	23.3
Day 16	1/22/2012	22.5	22.8	22.9	22.7	22.9	23
Day 17	1/23/2012	23	23.1	23.2	22.9	22.9	23
Day 18	1/24/2012	23.1	23.2	23.3	23	23.2	23.4
Day 19	1/25/2012	23	22.9	23.3	23	23.3	23.4
Day 20	1/26/2012	23	23.2	23.3	22.7	22.9	23.2
Day 21	1/27/2012	23	23.1	23.4	23	23.2	23.2
Day 22	1/28/2012	23.1	23.2	23.4	22.7	23	23.1
Day 23	1/29/2012	22.7	22.9	23.1	22.7	23	23.1
Day 24	1/30/2012	22.9	23	23.2	22.7	23	23.1
Day 25	1/31/2012	22.8	23.1	23.3	23	23.3	23.4
Day 26	2/1/2012	23.1	23.3	23.5	22.7	22.9	23.3
Day 27	2/2/2012	22.7	22.9	23.1	22.3	22.5	22.6
Day 28	2/3/2012	22.9	22.9	22.9			

Minimum (°C):	**22.5**	**22.5**	**22.9**	**22.3**	**22.4**	**22.5**
Maximum (°C):	**23.3**	**23.3**	**23.5**	**23.1**	**23.3**	**23.5**
Average (°C):	**22.9**	**22.9**	**23.2**	**22.8**	**22.9**	**23.1**

Aquatec Biological Sciences, Inc.

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SEDIMENT CHARACTERIZATION:

Sample Number	Client Sample ID	Sediment Characteristics	Pore Water pH	Organisms Present	Initial /Date 2012
41930 Sieved Y / N 0.5 Mesh size	Control	wet, sandy sediment w/silt	6.1	None seen	1/4
41931 Sieved: Y / N 500 µm Mesh size 0.5	APG-05/09-100411	Cohesive fine sediment, heavy w/vegetation, some stones, and clay	6.4	None seen	1/3 J
41932 Sieved: Y / N 0.5 Mesh size	APG-01-03-100411	Cohesive fine sediment, heavy w/vegetation, root mass, some clay, hydrocarbon odor	6.3	None seen	1/3 KK
41933 Sieved Y / N 0.5 Mesh size	APG-06/24-100411	Cohesive, fine mud, heavy w/vegetation, root mass	6.3	None seen	1/3 JG
41934 Sieved Y / N 0.5 Mesh size	APG-10/14-100411	Soft sediment, heavy w/ fibrous vegetative material	6.1	None seen.	1/3 J
41935 Sieved Y / N 0.5 Mesh size	APG-11/13-100411	Soft, cohesive sediment heavy w/vegetative material stones / clay	6.4	None seen	1/3 KK
41936 Sieved: Y / N 0.5 Mesh size	APG-16/17-100411	soft, cohesive sediment, heavy w/vegetative material	7.1	None seen	1/4 KK
41937 Sieved Y / N 0.5 Mesh size	APG-20/21-100411	fine, cohesive sediment, heavy w/ vegetative material, some clay and stones	6.8	None seen	1/4 J
41938 Sieved: Y / N 0.5 Mesh size	APG-18/19-100411	Soft cohesive sediment, heavy w/ vegetative material, some clay	6.7	None seen	1/4 JG
41939 Sieved Y / N 0.5 Mesh size	APG-04/07-100411	Soft, cohesive sediment w/ vegetative material some clay	6.5	None seen.	1/4 KK
41940 Sieved Y / N 0.5 Mesh size	APG-12/15-100511	Soft cohesive sediment w/ vegetative material, some clay	6.5	Tipulid larva	1/4 J
41941 Sieved: Y / N 0.5 Mesh size	APG-22/23-100511	soft, cohesive sediment w/ vegetative material.	6.3	None seen	1/4 KK
41942 Sieved Y / N 0.5 Mesh size	APG-02/08-100511	soft, Cohesive sediment w/ vegetative material	6.5	None seen	1/4 JG

Aquatec Biological Sciences, Inc.
Reviewed by: J Date: 1/5/11.

SDG: 12957
Project: 12008

Project: APG Lumbriculus Test ID: 63332 **WEEK OF:** 1/1/12

100.3 Oligochaete, L. variegatus, Bioaccumulation Test for sediments

Species: *Lumbriculus variegatus* Reference: EPA/600/R-99/064 SOP: TOX3-006

DAILY SEDIMENT MONITORING - CHECKLIST

ACTIVITY / DAY

AM

	SUNDAY	MONDAY	TUESDAY	WEDNESDAY	THURSDAY	FRIDAY	SATURDAY
Temperature(s): Probe #(s): SLZ Cart 1 - 8, Cart 2 - 7, Cart 3 - 6	Cart 4 - 3, Cart 5 - 2, Cart 6 - 1				TEST STARTS 41930, 31, 32, 33, 34, 35, 36 1/5/12 16:25	23.6 20.7 23.0 22.5 23.4 23.1	23.5 23.0 23.3 22.7 23.5 23.2
Fill Reservoirs					✓	✓	✓
Delivery tubes in place					✓	✓	✓
Check water Supply					✓	✓	✓
Empty Waste Buckets					✓	✓	✓
Aeration					✓	✓	✓
Chems Collected / ok?					✓	✓	✓

NOON

	SUNDAY	MONDAY	TUESDAY	WEDNESDAY	THURSDAY	FRIDAY	SATURDAY
Splitter box(s) filling?				✓	✓	✓	✓
Syringes filling?					✓	✓	✓
Flowing?					✓	✓	✓
Drainage to Waste - ok?					✓	✓	✓

PM

	SUNDAY	MONDAY	TUESDAY	WEDNESDAY	THURSDAY	FRIDAY	SATURDAY
SLZ Temperature(s): Cart 4 - Probe 3, Cart 5 - Probe 2, Cart 6 - Probe 1; Probe #(s): See Above					23.0 22.8 23.9	23.2 22.4 22.9 22.4 22.9 22.7	23.1 22.4 22.8 22.5 23.0 22.9
Fill Reservoirs				✓	✓	✓	✓
Delivery tubes in place				✓	✓	✓	✓
Waste tubes in place				✓	✓	✓	✓
Check water Supply				✓	✓	✓	✓
Empty Waste Buckets				✓	✓	✓	✓
Aeration				✓	✓	✓	✓
Date:				1/4/12	1/5/12	1-6-12	1-7-12
Initials:				[illegible]	[illegible] / JG	JG / [illegible]	JG

	SUNDAY	MONDAY	TUESDAY	WEDNESDAY	THURSDAY	FRIDAY	SATURDAY
Corrective Actions / Comments (Initial/Time)				Sediments loaded samples 41930, 31, 32, 33, 34, 35, 36 CARTS 1,2,3 OLW + AIR added.	Sediments loaded samples 41937, 38, 39, 40, 41, 42 CARTS 4,5,6 OLW + AIR ADDED	Cart 4 turned up in AM. JG Turned down Cart 1 very slightly 16:50	

Aquatec Biological Sciences, Inc.

Reviewed by: ______ Date: 2/6/12

SDG: 12957

Project: 12008

Project: APG Lumbriculus   Test ID: **63332**   **WEEK OF:** 1/8/12

100.3 Oligochaete, L. variegatus, Bioaccumulation Test for sediments

Species: *Lumbriculus variegatus*   Reference: EPA/600/R-99/064   SOP: TOX3-006

ACTIVITY / DAY

DAILY SEDIMENT MONITORING - CHECKLIST

AM

	SUNDAY	MONDAY	TUESDAY	WEDNESDAY	THURSDAY	FRIDAY	SATURDAY
Temperature(s): **Probe #(s):**	23.5 23.3 23.3 23.0 23.5 23.4	23.6 23.0 23.3 22.8 23.7 23.0	~~23.4~~ 23.0 ~~23~~ 22.9 23.8 23.4 23.2 23.6	23.8 22.9 23.3 23.1 23.9 23.1	23.7 23.0 23.1 22.9 23.8 23.2	23.6 23.1 23.3 23.0 23.7 23.4	23.6 22.9 23.2 22.9 23.8 23.3
Fill Reservoirs	✓	✓	✓	✓	✓	✓	✓
Delivery tubes in place	✓	✓	✓	✓	✓	✓	✓
Check water Supply	✓	✓	✓	✓	✓	✓	✓
Empty Waste Buckets	✓	✓	✓	✓	✓	✓	✓
Aeration	✓	✓	✓	✓	✓	✓	✓
Chems Collected / ok?	✓	✓	✓	✓	✓	✓	✓

NOON

	SUNDAY	MONDAY	TUESDAY	WEDNESDAY	THURSDAY	FRIDAY	SATURDAY
Splitter box(s) filling?	✓	✓	✓	✓	✓	✓	✓
Syringes filling?	✓	✓	✓ JG	✓	✓	✓	✓
Flowing?	✓	✓	✓	✓	✓	✓	✓
Drainage to Waste - ok?	✓	✓	✓	✓	✓	✓	✓

PM

	SUNDAY	MONDAY	TUESDAY	WEDNESDAY	THURSDAY	FRIDAY	SATURDAY
Temperature(s): **Probe #(s): See Above**	23.4 23.0 23.3 22.8 23.4 23.1	23.4 23.0 23.2 22.9 23.7 23.5	23.6 23.0 23.3 22.8 23.8 23.2	23.3 22.9 23.1 22.8 23.6 23.1	23.7 23.1 23.4 23.0 23.9 23.3	23.7 23.1 23.3 23.1 23.8 23.3	23.5 22.9 23.1 23.0 23.6 23.3
Fill Reservoirs	✓	✓	✓	✓	✓	✓	✓
Delivery tubes in place	✓	✓	✓	✓	✓	✓	✓
Waste tubes in place	✓	✓	✓	✓	✓	✓	✓
Check water Supply	✓	✓	✓	✓	✓	✓	✓
Empty Waste Buckets	✓	✓	✓	✓	✓	✓	✓
Aeration	✓	✓	✓	✓	✓	✓	✓
Date:	1/8/12	1/9/12	1/10/12	1/11/12	1-12-12	1-13-12	1-14-12
Initials:	KK	[illegible]	[illegible]	[illegible]	JG/[illegible]	JG	JG

	SUNDAY	MONDAY	TUESDAY	WEDNESDAY	THURSDAY	FRIDAY	SATURDAY
Corrective Actions / Comments (Initial/Time)				Cleared solenoid valve delivery to cart 4.			

Project: APG Lumbriculus Test ID: 63332 **WEEK OF:** 1/15/12

100.3 Oligochaete, L. variegatus, Bioaccumulation Test for sediments

Species: *Lumbriculus variegatus* Reference: EPA/600/R-99/064 SOP: TOX3-006

ACTIVITY / DAY

DAILY SEDIMENT MONITORING - CHECKLIST

AM

	SUNDAY	MONDAY	TUESDAY	WEDNESDAY	THURSDAY	FRIDAY	SATURDAY
Temperature(s): **Probe #(s):**	22.9 22.6 22.9 22.5 23.3 22.9	23.1 22.6 23.0 22.6 23.5 22.9	23.8 23.0 23.2 22.8 24.0 23.1	23.3 22.8 23.1 22.9 23.4 23.1	23.4 22.7 22.8 22.8 23.1 23.2	23.9 22.8 23.3 23.0 23.5 23.0	23.4 22.8 23.0 23.0 23.2 23.4
Fill Reservoirs	✓	✓	✓	✓	✓	✓	✓
Delivery tubes in place	✓	✓	✓	✓	✓	✓	✓
Check water Supply	✓	✓	✓	✓	✓	✓	✓
Empty Waste Buckets	✓	✓	✓	✓	✓	✓	✓
Aeration	✓	✓	✓	✓	✓	✓	✓
Chems Collected / ok?	✓	✓	✓	✓	✓	✓	✓

NOON

	SUNDAY	MONDAY	TUESDAY	WEDNESDAY	THURSDAY	FRIDAY	SATURDAY
Splitter box(s) filling?	✓	✓	✓	✓	✓	✓	✓
Syringes filling?	✓	✓	✓	✓	✓	✓	✓
Flowing?	✓	✓	✓	✓	✓	✓	✓
Drainage to Waste - ok?	✓	✓	✓	✓	✓	✓	✓

PM

	SUNDAY	MONDAY	TUESDAY	WEDNESDAY	THURSDAY	FRIDAY	SATURDAY
Temperature(s): **Probe #(s): See Above**	23.2 22.9 23.1 22.6 23.6 23.1	23.3 22.9 23.1 22.8 23.6 23.2	23.7 23.0 23.3 23.0 23.8 23.2	23.4 22.7 23.1 22.8 23.3 23.1	23.5 22.9 23.1 23.1 23.3 23.3	23.3 22.5 23.0 22.6 23.0 22.5	23.3 22.7 22.9 23.0 23.0 23.3
Fill Reservoirs	✓	✓	✓	✓	✓	✓	✓
Delivery tubes in place	✓	✓	✓	✓	✓	✓	✓
Waste tubes in place	✓	✓	✓	✓	✓	✓	✓
Check water Supply	✓	✓	✓	✓	✓	✓	✓
Empty Waste Buckets	✓	✓	✓	✓	✓	✓	✓
Aeration	✓	✓	✓	✓	✓	✓	✓
Date:	1/15/12	1/16/12	1/17/12	1/18/12	1-19-12	1/20/12	1-21-12
Initials:	KK	KK/J	J	KK/J	JG	J	JG

	SUNDAY	MONDAY	TUESDAY	WEDNESDAY	THURSDAY	FRIDAY	SATURDAY
Corrective Actions / Comments (Initial/Time)			Turned down temp setting to Lv Cart 3 (Ch 6)			Cleared clogged delivery port to 41936 B	

Aquatec Biological Sciences, Inc.

Reviewed by: J Date: 2/6/12

SDG: 12957
Project: 12008

Project: APG Lumbriculus   Test ID: 63332   **WEEK OF:** 1/22/12

100.3 Oligochaete, L. variegatus, Bioaccumulation Test for sediments

Species: *Lumbriculus variegatus*   Reference: EPA/600/R-99/064   SOP: TOX3-006

DAILY SEDIMENT MONITORING - CHECKLIST

ACTIVITY / DAY

AM

	SUNDAY	MONDAY	TUESDAY	WEDNESDAY	THURSDAY	FRIDAY	SATURDAY
Temperature(s): Probe #(s):	23.4 22.5 23.0 22.8 23.0 22.9	23.8 23.0 23.3 23.1 23.4 23.2	23.6 23.1 23.4 23.2 23.3 23.3	23.6 23.0 23.2 22.9 23.1 23.3	23.6 23.0 23.0 23.2 23.2 23.3	23.6 23.0 23.2 23.1 23.3 23.4	23.1 23.1 23.1 23.2 23.2 23.4
Fill Reservoirs	✓	✓	✓	✓	✓	✓	✓
Delivery tubes in place	✓	✓	✓	✓	✓	✓	✓
Check water Supply	✓	✓	✓	✓	✓	✓	✓
Empty Waste Buckets	✓	✓	✓	✓	✓	✓	✓
Aeration	✓	✓	✓	✓	✓	✓	✓
Chems Collected / ok?	✓	✓	✓	✓	✓	✓	✓

NOON

	SUNDAY	MONDAY	TUESDAY	WEDNESDAY	THURSDAY	FRIDAY	SATURDAY
Splitter box(s) filling?	✓	✓	✓	✓	✓	✓	✓
Syringes filling?	✓	✓	✓	✓	✓	✓	✓
Flowing?	✓	✓	✓	✓	✓	✓	✓
Drainage to Waste - ok?	✓	✓	✓	✓	✓	✓	✓

PM

	SUNDAY	MONDAY	TUESDAY	WEDNESDAY	THURSDAY	FRIDAY	SATURDAY
Temperature(s): Probe #(s): See Above	23.4 22.7 23.1 22.9 23.1 23.0	23.6 22.9 23.2 22.9 23.2 23.0	23.6 23.0 23.3 23.2 23.2 23.4	23.6 23.0 23.4 23.3 23.3 23.4	23.2 22.7 22.8 22.9 22.9 23.2	24.1 23.0 23.3 23.2 23.5 23.2	22.8 22.7 22.7 23.0 23.0 23.1
Fill Reservoirs	✓	✓	✓	✓	✓	✓	✓
Delivery tubes in place	✓	✓	✓	✓	✓	✓	✓
Waste tubes in place	✓	✓	✓	✓	✓	✓	✓
Check water Supply	✓	✓	✓	✓	✓	✓	✓
Empty Waste Buckets	✓	✓	✓	✓	✓	✓	✓
Aeration	✓	✓	✓	✓	✓	✓	✓
Date:	1/22/12	1/23/12	1-24-12	1-25-12	1-26-12	1-27-12	1-28-12
Initials:	RR	J	JG	JG	JG	JG/J	JG

	SUNDAY	MONDAY	TUESDAY	WEDNESDAY	THURSDAY	FRIDAY	SATURDAY
Corrective Actions / Comments (Initial/Time)					41931 seem to be fewer organisms apparent. J	Turned down temp setting for CERT1 J	

Aquatec Biological Sciences, Inc.

Reviewed by: J   Date: 2/6/12

SDG: 12957

Project: 12008

Project: APG Lumbriculus Test ID: 63332 **WEEK OF:** 1/29/12

100.3 Oligochaete, L. variegatus, Bioaccumulation Test for sediments

Species: *Lumbriculus variegatus* Reference: •EPA/600/R-99/064 SOP: TOX3-006

ACTIVITY / DAY

DAILY SEDIMENT MONITORING - CHECKLIST

AM

	SUNDAY	MONDAY	TUESDAY	WEDNESDAY	THURSDAY	FRIDAY	SATURDAY
Temperature(s): Probe #(s):	22.9 22.7 23.1 22.9 23.1 23.1	23.1 22.9 23.2 23.0 23.3 23.2	23.0 22.8 23.1 23.1 23.1 23.3	23.1 23.1 23.1 23.3 23.3 23.5	22.8 22.7 23.1 22.9 23.1 23.1	22.9 22.9 22.9	
Fill Reservoirs	✓	✓	✓	✓	✓		
Delivery tubes in place	✓	✓	✓	✓	✓		
Check water Supply	✓	✓	✓	✓	✓		
Empty Waste Buckets	✓	✓	✓	✓	✓	✓	
Aeration	✓	✓	✓	✓	✓	✓	
Chems Collected / ok?	✓	✓	✓	✓	✓	✓	

NOON

	SUNDAY	MONDAY	TUESDAY	WEDNESDAY	THURSDAY	FRIDAY	SATURDAY
Splitter box(s) filling?	✓	✓	✓	✓	✓		
Syringes filling?	✓	✓	✓	✓	✓		
Flowing?	✓	✓	✓	✓	✓		
Drainage to Waste - ok?	✓	✓	✓	✓	✓		

PM

	SUNDAY	MONDAY	TUESDAY	WEDNESDAY	THURSDAY	FRIDAY	SATURDAY
Temperature(s): Probe #(s): See Above	22.8 22.7 23.1 23.0 23.1 23.1	23.1 22.7 23.2 23.0 23.3 23.1	23.0 23.0 23.1 23.3 23.1 23.4	23.0 22.7 23.1 22.9 23.2 23.3	22.3 22.5 22.6		
Fill Reservoirs	✓	✓	✓	✓	✓		
Delivery tubes in place	✓	✓	✓	✓	✓		
Waste tubes in place	✓	✓	✓	✓	✓		
Check water Supply	✓	✓	✓	✓	✓		
Empty Waste Buckets	✓	✓	✓	✓	✓		
Aeration	✓	✓	✓	✓	✓		
Date:	1/29/12	1/30/12	1-31-12	2-1-12	2/2/12	2/3/12	
Initials:	KK	J	JG	JG/J	KK JG	J	

	SUNDAY	MONDAY	TUESDAY	WEDNESDAY	THURSDAY	FRIDAY	SATURDAY
Corrective Actions / Comments (Initial/Time)					41930 → 41936 TEST END 0630 → 1215 followed by depuration J	Samples 41937 → 41942 + 41930 Rep C ended ~ 10:30 followed by depuration J	

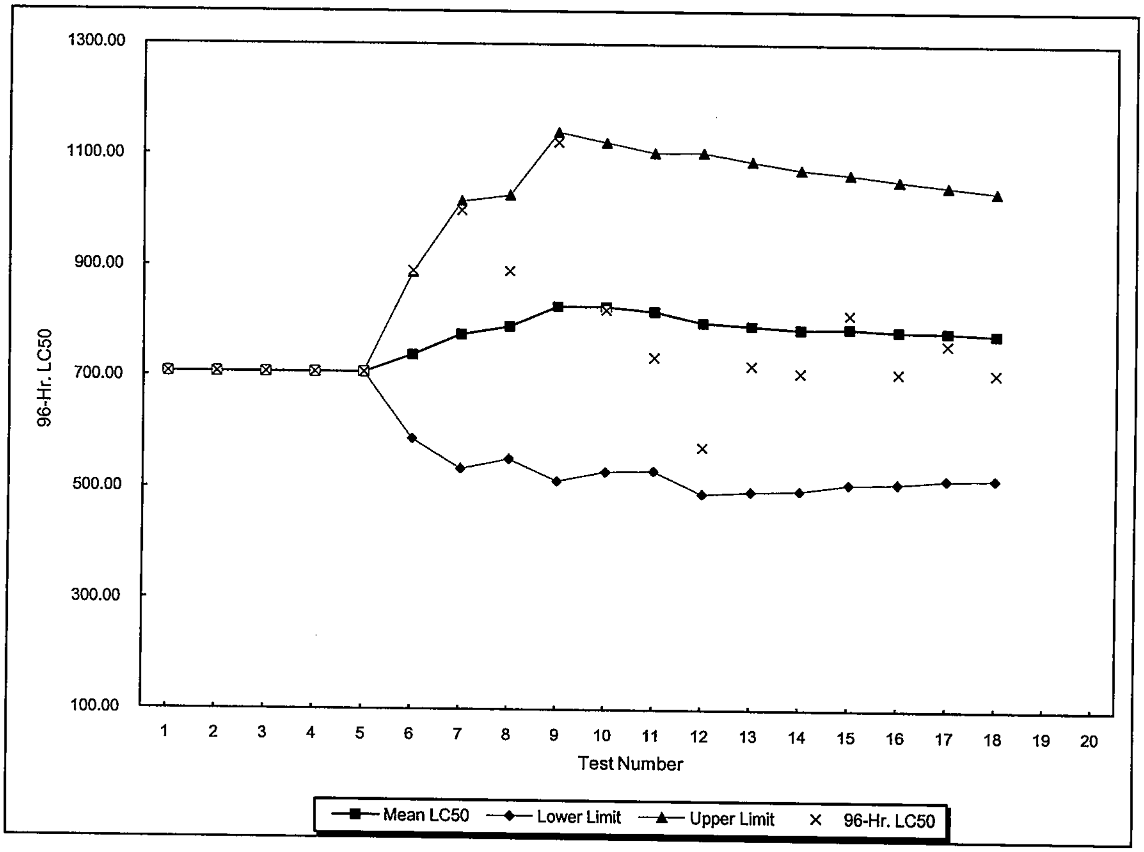
Aquatec Biological Sciences, Inc. **SDG:** 12957

Reviewed by: J Date: 2/6/12 **Project:** 12008

Standard Reference Toxicant Control Charts

Reference Toxicant Control Chart
Lumbriculus variegatus
in Potassium chloride (mg/L)

Test Number	Test Date	Organism Age (Days)	96-Hr. LC50	Mean LC50	Lower Limit	Upper Limit	Organism Source
1	08/11/00	Adult	707.107	707.11			Aquatic Research Organisms
2	08/14/00	Adult	707.107	707.11	707.11	707.11	Aquatic Research Organisms
3	08/14/00	Adult	707.107	707.11	707.11	707.11	Aquatic Research Organisms
4	08/15/00	Adult	707.107	707.11	707.11	707.11	Aquatic Research Organisms
5	08/15/00	Adult	707.107	707.11	707.11	707.11	Aquatic Research Organisms
6	10/19/01	Adult	890.899	737.74	587.67	887.80	Aquatic Research Organisms
7	10/30/01	Adult	1000.000	775.20	534.23	1016.18	Aquatic Research Organisms
8	11/01/01	Adult	890.899	789.67	552.04	1027.29	Aquatic Research Organisms
9	08/24/02	Adult	1122.460	826.64	512.59	1140.70	Aquatic Research Organisms
10	01/01/03	Adult	820.335	826.01	529.89	1122.13	Aquatic Research Organisms
11	05/02/03	Adult	734.867	817.73	531.47	1103.98	Aquatic Research Organisms
12	10/21/04	Adult	574.349	797.45	490.47	1104.42	Aquatic Research Organisms
13	10/23/04	Adult	720.123	791.50	494.48	1088.52	Aquatic Research Organisms
14	11/22/06	Adult	707.107	785.47	496.56	1074.38	Aquatic Research Organisms
15	11/07/09	Adult	812.250	787.25	508.51	1066.00	Aquatic Research Organisms
16	12/03/09	Adult	707.107	782.25	509.99	1054.51	Aquatic Research Organisms
17	10/06/10	Adult	758.000	780.82	516.94	1044.70	Aquatic Research Organisms
18	01/05/12	Adult	707.000	776.72	518.37	1035.07	Aquatic Research Organisms
19							
20							



\SRTS\LvAKCL

AECOM

AECOM Environment
4303 West LaPorte Avenue, Fort Collins, Colorado, 80521
T 970.416.0916 F 970.490.2963 www.aecom.com

December 5, 2011

Ryan McCarthy
AECOM Environment
250 Apollo Drive
Chelmsford, MA 01824

Subject: Report of Whole-Sediment Bioaccumulation Test

Dear Mr. McCarthy:

Attached is a copy of the report for the whole-sediment bioaccumulation tests using *Lumbriculus variegatus* conducted from July 19 to August 17, 2011 and July 26 to August 23, 2011. These tests were conducted with sediment samples collected on December 2 and 3, 2010. Please do not hesitate to contact one of us if you have any questions.

Sincerely,

Christina Needham
Data Analyst
christina.needham@aecom.com

Rami B. Naddy, Ph.D.
Study Director / Environmental Toxicologist
rami.naddy@aecom.com

Attachment:

60147216-445-(002-007, 008-012)

Report of a Whole Sediment Bioaccumulation Test using *Lumbriculus variegatus*

For

AECOM Environment
Chelmsford, MA, USA

Prepared by
AECOM Technical Services, Inc.
Fort Collins Environmental Toxicology Lab
December 2011

60147216-445-(002-012)

AECOM

Report of a Whole-Sediment Bioaccumulation Test using Lumbriculus variegatus

Project IDs: 60147216-445-(002-007, 008-012)
July – August 2011

Sponsor and Laboratory Information

Sponsor	AECOM Environment 250 Apollo Drive Chelmsford, MA 01824
Project Officer	Ryan McCarthy (603) 263-2147
Testing Facility	AECOM Environment Fort Collins Environmental Toxicology Laboratory 4303 West LaPorte Ave. Fort Collins, CO 80521 Fax: (970) 490-2963 State of Florida NELAP Laboratory ID: E87972
Study Director	Rami B. Naddy, Ph.D. (970) 416-0916 email: rami.naddy@aecom.com
Report Author	Christina Needham (970) 416-0916 email: christina.needham@aecom.com

Test Information

Test	Bioaccumulation from whole sediment	
Basis	USEPA (2000) and ASTM (2009)	
Test Dates and Time	July 19, 2011 - August 16 and 17, 2011 July 26, 2011 - August 23 and 24, 2011	
Test Length	~28 days	
Species	*Lumbriculus variegatus*	
Test Material	Whole sediments	
Sediment ID	Sample ID	AECOM Laboratory ID
	APG-05/09	24809
	APG-04/07	24815
	APG-22/23	24808
	APG-15/21	24813
	APG-06/24	24812
	APG-02/08	24816
	APG-11/13	24810
	APG-14/10	24814
	APG-12/20	24811
	APG-01/03	24817
Control Sediment	3% Organic Laboratory Formulated Sediment	
Overlying water	Filtered Horsetooth Reservoir water	
Test Concentrations	0 (control) and 100% of each test sediment	

Sediment Collection and Receipt

Sample ID	Collection Date and Time	AECOM No.	Date of Receipt	Cooler Temp. at Arrival (°C)
APG-05/09	December 3, 2010 @ 0730	24809	May 26, 2011	6.9, 7.5[a]
APG-04/07	December 3, 2010 @ 0820	24815	May 26, 2011	7.5[a]
APG-22/23	December 2, 2010 @ 1455	24808	May 26, 2011	6.1, 6.9
APG-15/21	December 2, 2010 @ 1055	24813	May 26, 2011	6.1
APG-06/24	December 2, 2010 @ 1210	24812	May 26, 2011	6.9[a]
APG-02/08	December 2, 2010 @ 1550	24816	May 26, 2011	7.5
APG-11/13	December 2, 2010 @ 0825	24810	May 26, 2011	6.9
APG-14/10	December 2, 2010 @ 0925	24814	May 26, 2011	6.1[a]
APG-12/20	December 2, 2010 @ 1009	24811	May 26, 2011	6.1, 6.9
APG-01/03	December 2, 2010 @ 1430	24817	May 26, 2011	7.5

[a] One sample bottle broken upon arrival at the FCETL
Note: See Appendix A for copies of chain of custody records

Laboratory Control Sediment

The control sediment used for all tests was laboratory formulated sediment with an estimated organic content of 3% (by weight). The formulated sediment was prepared by combining the following materials:

Material	Quantity (g) (Percent)
Rinsed Medium Grit Silica Sand	8500 (83.1)
Clay/Silt Mixture (ASP 400)	1500 (14.7)
Dolomite	5 (0.049)
Humic Acid (Sodium Salt)	1 (0.0098)
Sieved Sphagnum Moss	220 (2.15)

Prior to mixing, the sphagnum moss was sieved using a 2 mm sieve. The medium grit silica sand was rinsed with deionized water until the water ran clear and then the sand was baked overnight at 105°C. All ingredients were combined and mixed together for at least 15 minutes. Calcium carbonate was added at approximately 1% (by dry weight) to raise the soil pH from 3.4 to 6.8. At least 24 hours prior to homogenization, a small amount of filtered Horsetooth reservoir water was added to the necessary amount of formulated sediment and the wetted sediment was held at 4°C in the dark.

Test Dates and Times

Sample ID	Test Round	Test Initiation Date and Time	Test Termination Date and Time
APG-05/09, APG-04/07, APG-22/23, APG-15/21, and APG-06/24	1	July 19, 2011 @ 1400-1430	August 16, 2011 @ 0800-1830, August 17, 2011 @ 0800-1830
APG-02/08, APG-11/13, APG-14/10, APG-12/20, and APG-01/03	2	July 26, 2011 @ 1430-1500	August 23, 2011 @ 0730-1800, August 24, 2011 @ 0745-1930

Test Sediment Preparation

Sample ID	Date Homogenized	Time Homogenized
Test Round 1		
Control	July 18, 2011	1325-1330
APG-05/09		1424-1427
APG-04/07		1341-1344
APG-22/23		1441-1444
APG-15/21		1415-1418
APG-06/24		1350-1353
Test Round 2		
Control	July 25, 2011	0933-0936
APG-02/08		1023-1026
APG-11/13		1008-1011
APG-14/10		0941-0944
APG-12/20		1058-1101
APG-01/03		1043-1045

Test Conditions

Type	Bioaccumulation Test with Continuous Renewal of Overlying Water
Overlying Water Delivery System	Continuous renewal (flow-through)[a]
Test Endpoints	Body residue of chemicals of potential concern[b]
Test Chambers	2.5 gallon glass aquaria
Test Sediment Volume	1000 ml
Overlying Water Volume	2000 ml
Replicates per Treatment	3
Organisms per Replicate	Added by weight (see page 5)
Feeding	None
Test Temperature	23 ± 1°C (≤ 3°C differential)[c]
Lighting	Fluorescent, 16 hours light:8 hours dark
Chamber Placement	Non-Randomized
Test Sediment Renewal	None
Test Overlying Water Renewal	Approximately two to three volume additions per test chamber per day

[a] Continuous replacement via a drip system
[b] Results of chemical analysis of worm tissue not reported here
[c] The test temperature during Test Round 1 fell below the recommended lower limit of 22°C but did not exceed the 3°C differential. It is the study director's best professional judgment that this did not affect the outcome of the test.

Test Organism

Test Round 1	
Species and Lot Number	*Lumbriculus variegatus*, Lot 11-017
Age	Adult
Source	Bayou Aquatics, Ontario, CA
Test Round 2	
Species	*Lumbriculus variegatus*, Lot 11-018
Age	Adult
Source	Bayou Aquatics, Ontario, CA

Estimated Sediment Organic Content

In accordance with EPA guidance, the weight of worms added to each test chamber is dependent on the total organic carbon (TOC) content of the sediment. Worms are added at a minimum target ratio of 1 g dry weight of worms to 50 g sediment TOC (USEPA, 2000). This ratio was achieved for test sediments, but not for the controls, as TOC values were not known in advance of study initiation. The moisture content and estimated TOC of each test sediment are presented in the following table:

Sample ID	% Moisture (per mass wet)[a]	Vol. of Sediment in each Test Chamber (ml)	Approx. Wet Wt. (g) of Sediment in each Test Chamber[b]	Approx. Dry Wt. (g) of Sediment in each Test Chamber[c]	Approx. %TOC (by dry wt.)[a,d]	Estimated TOC (g) in each Test Chamber[e]
APG-05/09	58.4	1000	1100	458	12.6	57.7
APG-04/07	53.4	1000	1100	513	9.2	47.2
APG-22/23	56.4	1000	1100	480	21.2	101.8
APG-15/21	68.2	1000	1100	350	19.1	66.8
APG-06/24	45.2	1000	1100	603	8.8	53.1
APG-02/08	54.5	1000	1100	500	14.1	70.5
APG-11/13	67.9	1000	1100	353	26.9	95.0
APG-14/10	68.9	1000	1100	342	20.9	71.5
APG-12/20	72.7	1000	1100	300	22.9	68.7
APG-01/03	53.0	1000	1100	517	14.5	75.0

[a] Measured by the Environmental Research Group at The University of New Hampshire (Durham, NH)
[b] Calculated by multiplying volume of sediment in each test chamber by 1.1g/ml (average density of sediment determined for sediment samples received June 9, 2011)
[c] Calculated by multiplying Approx. Wet Wt. by [(100-% Moisture)/100]
[d] Calculated by averaging the % TOC values of the two sites composited for each sample
[e] Calculated using the dry weight per test chamber and approximate % TOC
Note: Values are rounded to one digit; some slight differences may be found when applying conversion factors to rounded values

TEST RESULTS

Weight of Worms Added and Removed From Test Chambers – Test Round 1

Sample ID	Rep	Wet Wt (unblotted) of Worms Added (g)	Est. Dry Wt. of Worms Added (g)[a,b]	Approx. TOC:Dry Worm Wt. Ratio	Wet. Wt. (unblotted) of Worms Recovered (g)	Percent Recovery
Control	A	2.6	0.23	22:1[c]	1.5	58%
	B	2.6	0.23	22:1[c]	1.7	65%
	C	2.5	0.22	23:1[c]	1.3	52%
APG-05/09	A	6.7	0.59	98:1	2.9	43%
	B	6.7	0.59	98:1	2.1	31%
	C	6.7	0.59	98:1	3.1	46%
APG-04/07	A	6.7	0.59	80:1	3.0	45%
	B	6.7	0.59	80:1	3.2	48%
	C	6.7	0.59	80:1	2.4	36%
APG-22/23	A	6.7	0.59	172:1	2.3	34%
	B	6.7	0.59	172:1	2.8	42%
	C	6.7	0.59	172:1	1.8	27%
APG-15/21	A	6.7	0.59	113:1	2.8	42%
	B	6.7	0.59	113:1	3.1	46%
	C	6.7	0.59	113:1	3.0	45%
APG-06/24	A	6.7	0.59	90:1	1.2	18%
	B	6.7	0.59	90:1	0.8	12%
	C	6.7	0.59	90:1	1.8	27%

[a] Calculated by dividing unblotted wet weight by 1.33 (USEPA, 2000) to obtain blotted wet weight and then multiplying estimated blotted wet weight by 0.117 (wet weight to dry weight conversion calculated by AECOM during previous studies)
[b] Values are rounded to two digits; some slight differences may be found when applying conversion factors to rounded values
[c] Calculated based on 5 g TOC/1000 ml wet volume determined by AECOM during previous studies.
Note: See Appendix B for Test Data

Weight of Worms Added and Removed From Test Chambers – Test Round 2

Sample ID	Rep.	Wet Wt. (unblotted) of Worms Added (g)	Est. Dry Wt. of Worms Added (g)[a,b]	Approx. TOC:Dry Worm Wt. Ratio	Wet. Wt. (unblotted) of Worms Recovered (g)	Percent Recovery
Control	A	2.6	0.23	22:1[c]	1.5	58%
	B	2.5	0.22	23:1[c]	0.4	16%
	C	2.6	0.23	22:1[c]	1.5	58%
APG-02/08	A	6.7	0.59	119:1	1.4	21%
	B	6.7	0.59	119:1	1.9	28%
	C	6.7	0.59	119:1	2.3	34%
APG-11/13	A	6.7	0.59	161:1	4.5	67%
	B	6.7	0.59	161:1	3.9	58%
	C	6.7	0.59	161:1	1.5	22%
APG-14/10	A	6.7	0.59	121:1	2.9	43%
	B	6.7	0.59	121:1	3.7	55%
	C	6.7	0.59	121:1	3.9	58%
APG-12/20	A	6.7	0.59	116:1	2.8	42%
	B	6.7	0.59	116:1	4.6	69%
	C	6.7	0.59	116:1	1.6	24%
APG-01/03	A	6.7	0.59	127:1	2.0	30%
	B	6.7	0.59	127:1	2.6	39%
	C	6.7	0.59	127:1	1.5	22%

[a] Calculated by dividing unblotted wet weight by 1.33 (USEPA, 2000) to obtain blotted wet weight and then multiplying estimated blotted wet weight by 0.117 (wet weight to dry weight conversion calculated by AECOM during previous studies)
[b] Values are rounded to two digits; some slight differences may be found when applying conversion factors to rounded values
[c] Calculated based on 5 g TOC/1000 ml wet volume determined by AECOM during previous studies.
Note: See Appendix C for Test Data

Physical and Chemical Data of Overlying water

Sample ID	pH	DO (mg/L)	Spec. Cond. (µS/cm)	Temperature (°C)[a]	NH_3-N (mg/L)	Hardness (mg/L as $CaCO_3$)	Alkalinity (mg/L as $CaCO_3$)
Test Round 1							
Control	7.8-8.2	5.7-6.8	125-270	21-23	<1.0	54-124	52-116
APG-05/09	7.3-8.0	4.5-6.2	155-501	20-23	<1.0-2.4	54-140	45-148
APG-04/07	7.5-8.0	4.5-7.1	137-453	20-23	<1.0-1.1	54-168	38-100
APG-22/23	5.6-7.4	4.3-6.4	125-393	20-23	<1.0-2.8	36-80	3-100
APG-15/21	6.5-7.8	4.0-6.1	168-472	20-23	<1.0-2.1	48-120	48-88
APG-06/24	6.6-7.6	4.2-6.7	153-386	20-23	<1.0-2.2	48-110	21-31
Test Round 2							
Control	7.9-8.3	5.6-6.8	160-187	21-23	<1.0-1.1	64-86	66-85
APG-02/08	7.3-8.0	4.5-6.8	123-244	21-23	<1.0-1.4	40-74	39-73
APG-11/13	7.0-7.7	4.2-6.8	91-150	21-23	<1.0-1.7	26-44	18-30
APG-14/10	7.2-7.7	3.8-6.8	131-237	21-23	<1.0-1.6	44-68	28-61
APG-12/20	7.3-7.9	4.0-6.8	132-320	21-23	<1.0-2.2	44-86	39-81
APG-01/03	7.3-7.8	4.6-6.7	150-247	21-23	<1.0-1.6	50-78	40-63

[a] Temperature in overlying water
Note: Continuous temperature in the water bath ranged from 20.4-23.2°C (Test Round1) and 20.2-22.4 (Test Round 2).

Depuration Period

At the end of the exposure period (~28 days), all worms were removed from each replicate and were held in separate 500-ml beakers containing Horsetooth Reservoir water overnight to allow clearance of gut contents. The following morning, organisms were cleaned, weighed, and frozen. The samples were shipped (on ice) to the Environmental Research Group at The University of New Hampshire, an independent laboratory located in Durham, New Hampshire, USA for tissue analysis.

References

ASTM. 2009. Standard Test Methods for Measuring the Toxicity of Sediment-Associated Contaminants with Freshwater Invertebrates. Method E 1688-00a in 2009 Annual Book of ASTM Standards, Section 11, Water and Environmental Technology, Volume 11.06, Biological Effects and Environmental Fate; Biotechnology. American Society of Testing and Materials.

USEPA. 2000. Methods for measuring the toxicity and bioaccumulation of sediment-associated contaminants with freshwater invertebrates. EPA/600/R-99/064. United States Environmental Protection Agency, Washington, DC.

Statement of Procedural Compliance

I certify that this document and all attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of the person or persons who manage the system, or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge, accurate and complete.

December 7, 2011

Rami B. Naddy, Ph.D.
Study Director

Date

Statement of Quality Assurance

The test data were reviewed by the Quality Assurance Unit to assure that the study was performed in accordance with the protocol and standard operating procedures. This report is an accurate reflection of the raw data.

Gina R McNerney / Anita Rehner

December 7, 2011

Quality Assurance Unit

Date

APPENDIX A

Chain of Custody Records

CHAIN OF CUSTODY RECORD

Client/Project Name: AECOM / UNH ESTCP Canal Creek Field Demo

Project Location: Aberdeen Proving Ground Edgewood, MD

Project Number: (AECOM) 60133180.502

Field Logbook No.: N/A

Sampler (Print Name)/(Affiliation): N/A

Chain of Custody Tape Nos.: N/A

Signature: N/A

Send Results/Report to: scott.greenwood@aecom.com ryan.mccarthy@aecom.com

TAT

REFER TO 12/02/2010 COC FOR SAMPLING DESCRIPTION

Analysis Requested: Lumbriculus Bioaccumulation

Preservation
1 – HCl, 4°
2 – H2SO4, 4°
3 – HNO3, 4°
4 – NaOH, 4°
5 – NaOH/ZnAc, 4°
6 – Na2S2O3, 4°
7 – 4°

Container Type
P – Plastic
A – Amber Glass
G – Clear Glass
O – Other

Field Sample No./Identification	Date	Time	COMP	GRAB	Matrix	Field Filtered	Lumbriculus Bioaccumulation							Sample #	Remarks cooler temp
APG-05/09 (A)			X				X							24809	7.5°C (bottle br
APG-05/09 (B)														24809	6.9°C
APG-05/09 (C)														24809	6.9°C
APG-05/09 (D)														24809	6.9°C
~~APG-05/09~~															
APG-04/07 (A)														24815	7.5°C
APG-04/07 (B)														24815	7.5°C
APG-04/07 (C)														24815	7.5°C
APG-04/07 (D)														24815	7.5°C (bottle br
APG-22/23 (A)														24808	6.1°C
APG-22/23 (B)														24808	6.1°C
APG-22/23 (C)														24808	6.9°C

Relinquished by: (Print Name)/(Affiliation) Scott Greenwood
Signature: Scott Greenwood
Date: 5/24/11 Time: 1000am

Received by: (Print Name)/(Affiliation) Emily Sadler | AECOM
Signature: Emily Sadler
Date: 5/26/11 Time: 1015

Relinquished by: (Print Name)/(Affiliation)
Signature:
Date:
Time:

Received by: (Print Name)/(Affiliation)
Signature:
Date:
Time:

Relinquished by: (Print Name)/(Affiliation)
Signature:
Date:
Time:

Received by: (Print Name)/(Affiliation)
Signature:
Date:
Time:

Analytical Laboratory (Destination):
AECOM TECHNICAL SERVICES
C/O David Pillard
4303 W. Laporte Ave
Fort Collins, CO 80521

Sample Shipped Via: UPS FedEx Co Other

Temp blank: Yes No

Rec'd on ice @ 6.1°C cooler #1 (therm D53)
7.5°C cooler #2
6.9°C cooler #3

CHAIN OF CUSTODY RECORD

Client/Project Name: AECOM / UNH ESTCP Canal Creek Field Demo

Project Location: Aberdeen Proving Ground Edgewood, MD

Project Number: (AECOM) 60133180.502

Field Logbook No.: N/A

Sampler (Print Name)/(Affiliation): N/A

Chain of Custody Tape Nos.: N/A

Signature: N/A

Send Results/Report to: scott.greenwood@unh.edu ryan.mccarthy@aecom.com

TAT

REFER TO 12/02/2010 COC FOR SAMPLING DESCRIPTION

Analysis Requested

Preservation
1 – HCl, 4°
2 – H2SO4, 4°
3 – HNO3, 4°
4 – NaOH, 4°
5 – NaOH/ZnAc, 4°
6 – Na2S2O3, 4°
7 – 4°

Container Type
P – Plastic
A – Amber Glass
G – Clear Glass
O – Other

Field Sample No./Identification	Date	Time	COMP	GRAB	Matrix	Field Filtered	Lumbriculus Bioaccumulation							Sample #	Remarks, cooler temp
APG- 15/21 (A)			X				X							24813	6.1°C
APG- 15/21 (B)														24813	6.1°C
APG - 15/21 (C)														24813	6.1°C
APG - 15/21 (D)														24813	6.1°C
APG - 06/24 (A)														24812	6.9°C (bottle broke
APG - 06/24 (B)														24812	6.9°C
APG - 06/24 (C)														24812	6.9°C
APG - 06(24) D														24812	6.9°C
APG - 02/08 (A)														24816	7.5°C
APG - 02/08 (B)														24816	7.5°C
APG - 02/08 (C)														24816	7.5°C
APG - 02/08 (D)														24816	7.5°C

Relinquished by: (Print Name)/(Affiliation)	Date/Time	Received by: (Print Name)/(Affiliation)	Date/Time
Scott Greenwood Signature: Scott Greenwood	Date: 5/24/11 Time: 10:00am	Emily Sadler / AECOM Signature: Emily Sadler	Date: 5/26/11 Time: 1015
Signature:	Date: Time:	Signature:	Date: Time:
Signature:	Date: Time:	Signature:	Date: Time:

Analytical Laboratory (Destination):
AECOM TECHNICAL SERVICES
C/O David Pillard
4303 W. Laporte Ave
Fort Collins, CO 80521

Sample Shipped Via: UPS FedEx Co Other

Temp blank: Yes No (thrown Dr

Rec'd on ice @ 6.1°C cooler #1
7.5°C cooler #2
6.9°C cooler #3

CHAIN OF CUSTODY RECORD

Client/Project Name: AECOM / UNH ESTCP Canal Creek Field Demo

Project Location: Aberdeen Proving Ground Edgewood, MD

Project Number: (AECOM) 60133180.502

Field Logbook No.: N/A

Sampler (Print Name)/(Affiliation): N/A

Chain of Custody Tape Nos.: N/A

Signature: N/A

Send Results/Report to: scott.greenwood@unh.edu ryan.mccarthy@aecom.com

TAT

REFER TO 12/02/2010 COC FOR SAMPLING DESCRIPTION

Analysis Requested: Lumbriculus Bioaccumulation

Preservation
1 – HCl, 4°
2 – H2SO4, 4°
3 – HNO3, 4°
4 – NaOH, 4°
5 – NaOH/ZnAc, 4°
6 – Na2S2O3, 4°
7 – 4°

Container Type
P – Plastic
A – Amber Glass
G – Clear Glass
O – Other

Field Sample No./Identification	Date	Time	COMP	GRAB	Matrix	Field Filtered	Lumbriculus Bioaccumulation						Remarks (sample #, cooler temp)
APG-11/13(A)			X				X						24810 6.9°C
APG-11/13(B)													24810 6.9°C
APG-11/13(C)													24810 6.9°C
APG-11/13(D)													24810 6.9°C
APG-14/10(A)													24814 6.1°C
APG-14/10(B)													24814 6.1°C (bottle brok
APG-14/10(C)													24814 6.1°C
APG-14/10(D)													24814 6.1°C
APG-12/20(A)													24811 6.9°C
APG-12/20(B)													24811 6.1°C
APG-12/20(C)													24811 6.1°C
APG-12/20(D)													24811 6.1°C

Relinquished by: (Print Name)/(Affiliation)	Date/Time	Received by: (Print Name)/(Affiliation)	Date/Time
Scott Greenwood; Signature: Scott Greenwood	Date: 5/24/11 Time: 10:00am	Emily Sadler / AECOM; Signature: Emily Sadler	Date: 5/26/11 Time: 1015
Signature:	Date: Time:	Signature:	Date: Time:
Signature:	Date: Time:	Signature:	Date: Time:

Analytical Laboratory (Destination):
AECOM TECHNICAL SERVICES
C/O David Pillard
4303 W. Laporte Ave
Fort Collins, CO 80521

Sample Shipped Via: UPS FedEx Co Other — FedEx

Temp blank: Yes No — No

Rec'd on ice @ 6.1°C cooler #1 (thermo DS...)
7.5°C cooler #2
6.9°C cooler #3

CHAIN OF COUSTODY RECORD

Client/Project Name: AECOM / UNH ESTCP Canal Creek Field Demo

Project Location: Aberdeen Proving Ground Edgewood, MD

Project Number: (AECOM) 60133180.502

Field Logbook No.: N/A

Sampler (Print Name)/(Affiliation): N/A

Chain of Custody Tape Nos.: N/A

Signature: N/A

Send Results/Report to: scott.greenwood@aecom.com ryan.mccarthy@aecom.com

TAT

REFER TO 12/02/2010 COC FOR SAMPLING DESCRIPTION

Analysis Requested

Preservation
1 – HCl, 4°
2 – H2SO4, 4°
3 – HNO3, 4°
4 – NaOH, 4°
5 – NaOH/ZnAc, 4°
6 – Na2S2O3, 4°
7 – 4°

Container Type
P – Plastic
A – Amber Glass
G – Clear Glass
O – Other

Field Sample No./Identification	Date	Time	COMP	GRAB	Matrix	Field Filtered	Lumbriculus Bioaccumulation							Sample #	Remarks Cooler temp
APG-22/23 (D)			X				X							24808	6.1°C
APG-01/03 (A)														24817	7.5°C
APG-01/03 (B)														24817	7.5°C
APG-01/03 (C)														24817	7.5°C
APG-01/03 (D)														24817	7.5°C

Relinquished by: (Print Name)/(Affiliation)	Date/Time	Received by: (Print Name)/(Affiliation)	Date/Time
Scott Greenwood Signature: Scott Greenwood	Date: 5/24/11 Time: 1000 2m	Emily Sadler / AECOM Signature: Emily Sadler	Date: 5/26/11 Time: 1015
Signature:	Date: Time:	Signature:	Date: Time:
Signature:	Date: Time:	Signature:	Date: Time:

Analytical Laboratory (Destination):
AECOM TECHNICAL SERVICES
C/O David Pillard
4303 W. Laporte Ave
Fort Collins, CO 80521

Sample Shipped Via: UPS (FedEx) Co Other

Temp blank: Yes (No) thermo DS3

Rec'd on ice @ 6.1°C cooler #1
7.5°C cooler #2
6.9°C cooler #3

APPENDIX B

Test Round 1 Laboratory Data Sheets

TOXICITY DATA PACKAGE COVER SHEET

CW 10/12/11
QA: GWM 11/9/11

Test Type: Chronic

Test Substance: Sediment

Overlying Water Type: Filtered Horsetooth water

Concurrent Control Sediment Type: Formulated Sediment

Date and Time Test Began: 7/19/11 @ 1400-1430

Protocol Number: USEPA (2000)

Project Number: 60147216-445(002-007)

Species: *Lumbriculus variegatus*

Organism Lot or Batch Number: 11-017

Age: adult (adult) Supplier: Bayou Aquatics

Date and Time Test Ended: 8/16-8/17 @ 0800-1830

Investigator(s): AMW/CW/NLT/KB/[illegible]/AB/AP

Background Information

Type of Test: Continuous Drip Renewal

pH Control?: Yes No If Yes, give % CO_2: N/A

Test Temperature: 23 ± 1 °C

Env. Chmbr/Bath #: 4 Test Chambers: 2.5 gal glass aquaria

Test Sediment Vol.: 1000 ml Overlying Water Volume: ~2 L Number of Replicates per Treatment: 3

Length of Test: 28 days Number of Organisms per Replicate: to maintain > 5:1 sediment organic carbon:org. dry weight

Type of Food and Quantity per Chamber: None Feeding Frequency: NA

Photoperiod: 16h Light : 8h Dark Light Intensity: 9.3-93 ft-c.

Overlying Water Characterization Parameters and Frequency:

NH_3: Day 0,7,14,21,~~17~~ 27 ①

pH: Day 0,7,14,21,~~17~~ 27 ①

Hardness: Day 0,7,14,21,27

Alkalinity: Day 0,7,14,21,27

Conductivity: Day 0,7,14, 21,27

TRC: NA

Test Concentrations: Formulated Sediment, APG-05/09, APG-04/07, APG-22/23, APG-15/21, and APG-06/24

Reference Toxicant Data: Test Dates: NA to —		LC_{50} or IC_{25} (Circle): —
Hist. 95% Control Limits: NA to —		Method for Determining Ref. Tox. Value: —

Special Procedures and Considerations:
Sediments will be homogenized before use in testing.
Hard/alk, pH, cond, and NH_3 of the overlying water will be measured on days 0, 7, 14, 21, and 27
DO will be measured daily and is to be maintained at ≥2.5 mg/L
Overlying water renewal rate at approximately 2 volume additions (4000 ml) per day, or ~~2.3~~ ~2.8 ② ml/min
Study Director Initials: RDW Date: 7/18/11

① RDW 7/18/11
② CW 11/15/11 CF
③ CW 11/15/11 E

SEDIMENT/SOIL PREPARATION

Project Number: 60147216-445-(002-007)

CW 10/12/11
QA: GLM 11/9/11

Artificial soil	
Constituent/source	**Amount added (g)**
Rinsed Medium Grit Silica Sand	8500
Clay/Silt Mixture (ASP 400)	1500
Dolomite	5
Humic Acid (Sodium Salt) (Lot #C10-034)	1
Sieved Sphagnum Moss	220
Calcium Carbonate (Lot #C02-064)	109

Notes: Medium grit silica sand was rinsed with deionized water and baked overnight in 105°C oven prior to sediment mixing.
Sphagnum Moss was sieved using a 2 mm sieve prior to mixing. Calcium carbonate added to raise soil pH from 3.4 to final pH of 6.8.

Soil/sediment	FCETL#	Homogenization			
		Date	From	To	Analyst
Form. Sed	N/A	7/18/11	1325	1330	CW
APG-05/09	24809	7/18/11	1424	1427	CW
APG-04/07	24815	7/18/11	1341	1344	AMM
APG-22/23	24808	7/18/11	1441	1444	AMM
APG-15/21	24813	7/18/11	1415	1418	NLT
APG-06/24	24812	7/18/11	1350	1353	NLT

OCW 11/15/11 E

QA: GMM 11/30/11

SUBJECT: DAILY LOG

ALL ENTRIES MUST BE INITIALLED WITH DATE AND TIME:

Preparation of 3% organic Laboratory Formulated Sediment 5/27/11 @1530

- Rinsed ~10L Medium grit silica sand with deionized water until rinse water was clear. Placed rinsed sand in baking dishes and baked overnight in 105°C oven. Sand was removed from oven and allowed to cool prior to mixing.

- Mixed together the following materials in a ~~10~~ 5 gal clean bucket:
  - Rinsed & baked Medium grit silica sand - 8500 g
  - Clay/silt mixture (ASP 400) - 1500 g
  - Dolomite - 5 g
  - Humic Acid (Lot# C10-034) - 1 g
  - Sieved (using 2 mm sieve) Sphagnum moss - 220 g
- Mixture was shaken for ~15 min to thoroughly combine materials.

Soil pH - 3.4

6/29/11 CW
- Added 108.9 g $CaCO_3$ (Lot# C02-064) to ~24 lbs formulated Sediment to raise the soil pH.

Soil pH - 6.8

CW 5/27/11 E

BIOLOGICAL DATA

CW 10/12/11

Project Number: 60147216-445(002-007)	Test Species (Circle): H. azteca C. tentans E. foetida **L. variegatus** Other (Specify):

QA: DLM 11/30/11

Treatment / Sediment	Rep.	Initial				Final
		Wet Weight Unblotted worms (g)[a]	Calculated Wet Weight Blotted Worms[b]	Calculated Dry Weight Worms[c]	Sediment Organic:Dry Worm Weight Ratio[d]	Wet Weight Unblotted Worms (g)[a,e]
Form. Sed	A	2.6				① ~~1.4~~ 1.5
	B	2.6				1.7
	C	2.5				1.3
APG-05/09	A	6.7				2.5+0.4
	B	6.7				1.6 +0.5
	C	6.7				2.1 +1.0
APG-04/07	A	6.7				3.0
	B	6.7				1.7 +1.5
	C	6.7				2.4
APG-22/23	A	6.7				2.3
	B	6.7				2.1 +0.7
	C	6.7				1.2+0.6
APG-15/21	A	6.7				2.6+0.2
	B	6.7				2.3 +0.8
	C	6.7				1.7 +1.3
APG-06/24	A	6.7				1.1 +0.1
	B	6.7				0.7 +0.1
	C	6.7				1.6 +0.2
Date		7/19/11				8/17/11
Time		1400-1430				0930-1530
Analyst		CW/NLT				CW/TE/DM

[a] Measured Using Balance Number AND Top Loader
[b] Unblotted wet weight of worms divided by 1.33
[c] Ratio applied to ② unblotted wet weight of worms : 0.117
[d] Sediment organic content calculated NA ④
[e] Organisms depurated from 8/16+8/17 @ ③ 1700 to 8/17+8/18/11 @ 0800 (date/time) in horsetooth water / 500mL beakers (water/holding vessel)

① TE 8/17/11 E
② CW 10/12/11 E
③ CW 11/15/11 CF

④ CW 11/15/11 E

BIOLOGICAL DATA

Project Number: 60147216-445-(002-007)

Test Species: *Lumbriculus variegatus*

		Initial			Final	
Treatment/Sediment	Rep	Wet Weight of Unblotted Worms (g)	Est. Blot Dry Wt. of Worms Added (g)[a]	Est. Dry Wt. of Worms Added (g)[a]	Wet Weight of Unblotted Worms (g)	% Recovery
Form Sed	A	2.6	1.95	0.23	1.5	58%
	B	2.6	1.95	0.23	1.7	65%
	C	2.5	1.88	0.22	1.3	52%
APG-05/09	A	6.7	5.04	0.59	2.9	43%
	B	6.7	5.04	0.59	2.1	31%
	C	6.7	5.04	0.59	3.1	46%
APG-04/07	A	6.7	5.04	0.59	3.0	45%
	B	6.7	5.04	0.59	3.2	48%
	C	6.7	5.04	0.59	2.4	36%
APG-22/23	A	6.7	5.04	0.59	2.3	34%
	B	6.7	5.04	0.59	2.8	42%
	C	6.7	5.04	0.59	1.8	27%
APG-15/21	A	6.7	5.04	0.59	2.8	42%
	B	6.7	5.04	0.59	3.1	46%
	C	6.7	5.04	0.59	3.0	45%
APG-06/24	A	6.7	5.04	0.59	1.2	18%
	B	6.7	5.04	0.59	0.8	12%
	C	6.7	5.04	0.59	1.8	27%

[a] Calculated by dividing unblotted wet weight by 1.33 (USEPA, 2000) to obtain blotted wet weight and then multiplying estimated blotted wet weight by 0.117 (wet weight to dry weight conversion calculated by FCETL during previous studies)

Note: Values are rounded to two digits; some slight differences may be found when applying conversion factors to rounded values

①CW 11/15/11 E

CHEMICAL DATA

cw 10/12/11

Project Number: 60147216-445(002-007)	Test Species (Circle): D. magna H. azteca C. tentans E. foetida **L. variegatus**	Other (Specify):	QA: GWM 11/10/11

pH

Test sediment	A	B	C	~~A~~	B	C	A
Test day	0	1	2	3	4	5	6
Form Sed	8.2	7.8	8.1	~~8.1~~ NR	8.1	8.1	② ~~8.1~~ NR
APG-05/09	7.3	7.4	7.5	① ~~8.0~~ NR	8.0	7.6	② ~~7.9~~ NR
APG-04/07	7.6	7.5	7.5	① ~~7.6~~ NR	7.6	7.7	② ~~8.0~~ NR
APG-22/23	7.1	7.1	7.0	① ~~6.8~~ NR	6.8	6.4	② ~~6.6~~ NR
APG-15/21	7.4	7.2	7.3	① ~~7.2~~ NR	7.2	6.9	② ~~7.7~~ NR
APG-06/24	7.2	7.1	7.0	NR	7.2	7.1	② ~~7.2~~ NR
Meter	16	16	16	16 ③	16	16	② ~~16~~
Date	7/19/11	7/20/11	7/21/11	~~7/22/11~~	7/23/11	7/24/11	② ~~7/25/11~~
Time	0940	1040	1540		1700	1610	② ~~1045~~
Initials	cw	KB	KB	KB	KB	KB	② ~~NLT~~

Dissolved Oxygen (mg/L)

Test sediment	A	B	C	~~A~~	B	C	A
Test day	0	1	2	3	4	5	6
Form Sed	6.5	6.1	5.9	NR	5.9	5.7	NR
APG-05/09	6.0	4.5	5.1	NR	4.6	5.0	NR
APG-04/07	6.3	6.2	5.2	NR	4.8	5.1	NR
APG-22/23	6.0	4.3	4.8	NR	4.6	4.6	NR
APG-15/21	6.1	6.1	5.0	NR	4.2	5.4	NR
APG-06/24	6.1	6.0	4.9	NR	4.8	4.6	NR
Meter	5	5	5	③	5	5	
Date	7/19/11	7/20/11	7/21/11	~~7/22/11~~	7/23/11	7/24/11	
Time	0940	1040	1540		1700	1610	
Initials	cw	KB	KB		KB	KB	

Temperature

Test sediment	A	B	C	~~A~~	B	C	A
Test day	0	1	2	3	4	5	6
Form Sed	23	23	22	NR	22	22	NR
APG-05/09	22	23	22	NR	22	23	NR
APG-04/07	23	23	22	NR	22	23	NR
APG-22/23	22	23	22	NR	22	23	NR
APG-15/21	23	23	22	NR	22	23	NR
APG-06/24	22	23	22	NR	22	23	NR
Meter	D41	D41	D41	D41 ③	D41	D41	
Date	7/19/11	7/20/11	7/21/11	~~7/22/11~~	7/23/11	7/24/11	
Time	0940	1040	1530		1700	1610	
Initials	cw	KB	KB		KB	KB	

pH

Test sediment	B	C	A	~~B~~	C	A	B
Test day	7	8	9	10	11	12	13
Form Sed	8.1	8.1	8.1	8.2	8.1	8.1	8.1
APG-05/09	7.7	7.9	7.9	7.8	7.7	7.8	7.8
APG-04/07	7.7	7.8	8.0	8.0	7.7	7.8	7.8
APG-22/23	6.4	6.4	5.6	5.8	6.0	6.0	6.8
APG-15/21	7.3	7.4	7.7	7.8	7.4	7.4	7.6
APG-06/24	7.0	7.3	7.2	7.4	7.3	7.1	7.3
Meter	16	16	16	16	16	16	16
Date	7/26/11	7/27/11	7/28/11	7/29/11	7/30/11	7/31/11	8/1/11
Time	0915	1050	1045	1435	1430	1515	1115
Initials	KB	KB	NLT	DM	AB	AB	AB

Dissolved Oxygen (mg/L)

Test sediment	B	C	A	~~B~~	C	A	B
Test day	7	8	9	10	11	12	13
Form Sed	6.0	5.9	6.8	6.2	6.0	6.0	6.0
APG-05/09	5.4	5.3	6.2	5.9	5.3	5.2	4.8
APG-04/07	5.2	5.4	7.1	5.8	5.5	4.9	5.1
APG-22/23	5.0	4.9	6.4	6.1	5.1	4.6	5.5
APG-15/21	4.5	4.9	5.7	6.0	5.0	4.3	5.0
APG-06/24	4.2	4.4	6.3	5.8	4.7	5.2	5.0
Meter	5	5	5	5	5	5	5
Date	7/26/11	7/27/11	7/28/11	7/29/11	7/30/11	7/31/11	8/1/11
Time	0915	1050	1045	1435	1430	1515	1115
Initials	KB	KB	NLT	DM	AB	AB	AB

Temperature

Test sediment	B	C	A	~~B~~	C	~~A~~	B
Test day	7	8	9	10	11	12	13
Form Sed	22	22	22	22	22	23	22
APG-05/09	22	22	22	22	22	23	22
APG-04/07	22	22	22	22	22	23	22
APG-22/23	22	22	22	22	22	23	22
APG-15/21	22	22	22	22	22	23	22
APG-06/24	22	22	22	22	22	23	22
Meter	D41	D41	D41	D41	D41	D41	D41
Date	7/26/11	7/27/11	7/28/11	7/29/11	7/30/11	7/31/11	8/1/11
Time	0915	1045	1045	1435	1425	1515	1115
Initials	KB	KB	NLT	DM	AB	AB	AB

NR = Not Recorded

① KB 7/23/11 E
② NLT 7/28/11 E
③ cw for KB 10/12/11 WP
④ cw 11/15/11 E

CHEMICAL DATA

CW 10/12/11

Project Number: 60147216-445(002-007)	Test Species (Circle): D. magna H. azteca C. tentans E. foetida **L. variegatus** Other (Specify): QA: AM 11/10/11

Test sediment	pH C 14	pH A 15	pH B 16	pH 17	pH A 18	pH B 19	pH C 20	DO C 14	DO A 15	DO B 16	DO 17	DO A 18	DO B 19	DO C 20	Temp C 14	Temp A 15	Temp B 16	Temp 17	Temp A 18	Temp B 19	Temp C 20
Form Sed	8.1	8.1	8.1	8.1	8.1	8.1	8.2	6.2	5.8	6.3	6.3	6.3	6.4	6.3	22	23	22	22	22	22	21
APG-05/09	7.8	7.9	7.8	7.7	7.8	7.7	7.8	5.2	4.6	5.3	5.3	5.4	5.0	5.5	22	23	22	22	22	22	20
APG-04/07	7.8	7.9	7.8	7.8	7.8	7.8	7.8	5.3	4.5	5.1	5.6	4.9	5.4	5.5	22	23	22	22	22	22	20
APG-22/23	6.4	7.2	6.9	(3) 6.4	7.4	6.4	6.8	5.3	4.5	5.7	5.3	4.8	5.2	5.1	22	23	22	22	22	22	20
APG-15/21	7.7	7.4	7.8	7.6	7.4	7.3	7.3	5.4	4.7	5.9	5.0	4.6	4.8	4.5	22	23	22	22	22	22	20
APG-06/24	7.0	7.6	7.6	7.0	7.2	7.3	6.9	4.9	5.6	6.0	5.1	4.7	5.2	4.9	22	23	22	22	22	22	20
Meter	16	16	16	16	16	16	16	5	5	5	5	5	5	5	D41	D41	D41	D41	D41	D41	D41
Date	8/2/11	8/3/11	8/4/11	8/5/11	8/6/11	8/7/11	8/8/11	8/2/11	8/3/11	8/4/11	8/5/11	8/6/11	8/7/11	8/8/11	8/2/11	8/3/11	8/4/11	8/5/11	8/6/11	8/7/11	8/8/11
Time	0905	1545	1030	0955	1505	1400	1100	0905	1545	1030	0955	1510	1405	1100	0905	1545	1020	0955	1505	1400	1100
Initials	CW	NLT	DM	AM	AP	AP	AB	CW	NLT	DM	AM	AP	AP	AB	CW	NLT	DM	AM	AP	AP	AB

Test sediment	pH 21	pH B 22	pH C 23	pH 24	pH B 25	pH C 26	pH A 27	DO 21	DO B 22	DO C 23	DO 24	DO B 25	DO C 26	DO A 27	Temp 21 ▲	Temp B 22	Temp C 23	Temp 24	Temp B 25	Temp C 26	Temp A 27
Form Sed	8.1	8.2	8.2	8.2	8.2	8.1	8.2	6.3	6.2	6.2	6.2	5.8	6.0	6.2	21	22	21	21	22	22	21
APG-05/09	7.8	7.8	7.8	7.7	7.7	7.6	7.8	5.2	5.0	5.0	5.0	5.8	5.9	5.4	21	22	21	21	22	22	21
APG-04/07	7.8	7.8	7.8	7.7	7.7	7.6	7.8	5.5	5.1	5.2	5.2	4.8	4.6	5.2	21	22	21	21	22	22	21
APG-22/23	5.6	6.3	5.8	6.3	6.0	6.1	6.4	4.9	5.1	5.4	4.8	5.0	4.4	5.5	21	22	21	21	21	21	21
APG-15/21	7.6	7.5	7.5	6.9	6.5	6.5	7.4	5.3	4.6	5.7	4.2	4.8	4.0	4.6	21	22	21	21	21	21	21
APG-06/24	7.0	7.3	7.6	7.0	6.7	6.6	7.2	5.5	5.9	5.5	4.8	4.6	5.0	~~5.6~~ (3) 6.7	21	22	21	21	21	21	21
Meter	16	16	16	16	16	16	16	5	5	5	5	6	6	5	D41	D41	D41	D41	D41	D41	D41
Date	8/9/11	8/10/11	8/11/11	8/12/11	8/13/11	8/14/11	8/15/11	8/9/11	8/10/11	8/11/11	8/12/11	8/13/11	8/14/11	8/15/11	8/9/11	8/10/11	8/11/11	8/12/11	8/13/11	8/14/11	8/15/11
Time	0900	1030	0910	1610	1740	1210	0935	0900	1030	0910	1610	1740	1210	0935	0900	1030	0910	1610	1735	1210	0910
Initials	CW	AM	AB	NLT	AP	NLT	AS/AM	CW	AM	AB	NLT	AP	NLT	AS/AM	CW	AM	AB	NLT	AP	NLT	AS

(1) AM 8/5/11 E
(2) AM 8/15/11 E
(3) CW 11/15/11 E

▲ Adjusted temperature of bath up.

CHEMICAL DATA

cw 10/12/11

Project Number: 60147216-445-(002-007)	Test Species (Circle): D. magna H. azteca C. tentans E. foetida **L. variegatus** Other (Specify): QA-gum 11/10/11

Test sediment	pH							Dissolved Oxygen (mg/L)							Temperature						
	Test day							Test day							Test day						
	28							28							28						
Form Sed	8.2							6.3							21						
APG-05/09	8.0							5.4							21						
APG-04/07	8.0							5.5							21						
APG-22/23	6.7							5.3							21						
APG-15/21	7.7							4.8							21						
APG-06/24	7.4							5.6							21						
Meter	16							5							D41						
Date	8/16/11							8/16/11							8/16/11						
Time	0905							0906							0810						
Initials	KB							KB							cw						

DCW 11/15/11 E

OVERLYING WATER CHARACTERIZATION

QA: RWM 11/10/11
CW 10/12/11

Project Number: 60147216-445(002-007)

Test Species (Circle): D. magna H. azteca C. tentans E. foetida **L. variegatus** Other (Specify):

Conc.	Hardness (mg/L $CaCO_3$)					Alkalinity (mg/L $CaCO_3$)					Conductivity (µS/cm)					NH_3 (mg/L)				
	0	7	14	21	27	0	7	14	21	27	0	7	14	21	27	0	7	14	21	27
Form Sed	54	124	104 ~~86~~②	72	94	52	116	99 ~~83~~②	70	94	125	270	228 ~~187~~②	164	201	<1.0	<1.0	<1.0 ~~1.1~~②	<1.0	<1.0
APG-05/09	54	140	138	98	120	45	148	127	91	111	155	501 ~~472~~①	411	292	328	<1.0	<1.0	2.4	<1.0	<1.0
APG-04/07	54	168	128	90	112	38	100	92	71	91	137	453	354	242	280	<1.0	<1.0	1.1	<1.0	<1.0
APG-22/23	36	80	70	56	62	21	100	5	3	3	125	393 ~~386~~①	284	256	276	<1.0	<1.0	2.1	2.4	2.8
APG-15/21	48	120	84	66	84	48	88	73	60	78	168	472 ~~501~~①	295	198	233	<1.0	<1.0	2.1	<1.0	<1.0
APG-06/24	48	110	82	70	72	25	22	31	22	21	153	386 ~~393~~①	305	242	246	<1.0	<1.0	2.2	<1.0	<1.0
Meter#	Titr	Titr	Titr	Titr	Titr	Titr	Titr	Titr	Titr	Titr	15	15	15	15	15	HA#1	HA#1	HA#1	HA#1	HA#1
Date:	7/19/11	7/26/11	8/2/11	8/9/11	8/15/11	7/19/11	7/26/11	8/2/11	8/9/11	8/15/11	7/19/11	7/26/11	8/2/11	8/9/11	8/15/11	7/19/11	7/26/11	8/2/11	8/9/11	8/15/11
Time:	1100	1430	0900	0840	0900	1100	1430	0900	0840	0900	1100	1430	0900	0840	0900	1100	1430	1420	1330	1700
Initials:	NLT	NLT	CW for TK	CW for TK	CW for AS	NLT	NLT	CW for TK	CW for TK	CW for AS	NLT	NLT	CW for TK	CW for TK	CW for AS	NLT	NLT	CW for DM	CW for TK	CW for KB

① NLT 7/26/11
② CW 10/12/11 E
③ CW 11/15/11 E

DAILY TOXICITY TEST LOG

CW 10/12/11

Project Number: 60147216-445 (002-007)	Test Species (Circle): D. magna H. azteca C. tentans E. foetida **L. variegatus** Other (Specify): QA: GLM 11/30/11

Test Day	Comments Not Randomized	Feeding (None)	Date & Initials
-1	Chambers filled with sediments and overlying water placed in test bath @ 1330-1445 Water drip started @ 1500 approx. drip rate = 2.8 mLs/min	None	CW 7/18/11
0	Test Organisms added @ 1400-1430 CT = 22.4 Range 21.4 to 22.8 °C	None	CW 7/19/11
1	CT = ① ~~21.6~~ 22.6 Range ~~21.2~~ 22.2 to ~~22.0~~ ① 22.8 °C	None	KB 7/20/11
2	CT = ~~21.4~~ ① 22.2 Range ① ~~20.6~~ 21.8 to ~~22.4~~ ① 22.6 °C	None	KB 7/21/11
3	CT = 21.8 Range 21.4 to 22.2 °C	None	CW for ? 7/22/11
4	CT = 21.8 Range ② ~~20.6~~ 21.4 to ② ~~21.2~~ 22.6 °C	None	KB 7/23/11
5	CT ① ~~21.0~~ 22.2 Range ~~20.8~~ 21.4 to ~~21.6~~ ① 22.8 °C	None	KB 7/24/11
6	CT = 22.6 Range 22.2 to 23.2 °C	None	CW for ? 7/25/11
7	CT = ~~21.0~~ 22.2 Range 21.8 to 22.6 °C	None	KB 7/26/11
8	CT = ~~22.0~~ 22.2 °C ③ Range ~~21.2 to 22.4~~ 21.8 - 22.2 °C ③	None	KB 7/27/11
9	CT = 21.6 Range 21.4 to 21.8 °C	None	NG 7/28/11
10	CT = 21.6 Range 20.8 to 22.2 °C	None	DM 7/29/11
11	CT = ~~21.5~~ 22.0 °C ④ Range ~~21.2 to 22.0~~ ④ 21.4 - 22.6 °C	None	7/30/11
12	CT = ~~22.6~~ ⑤ 22.2 °C Range 21.4 to 22.8 °C	None	CW for AS 7/31/11
13	CT = 22.4 Range 21.8 to 22.8 °C	None	8/1/11 CW for AB
14	CT = 22.2 Range 21.8 to 22.6 °C	None	8/2/11 CW

① KB 7/27/11 E
② CW 11/15/11 E
③ GLM for KB 11/30/11 GE
④ GLM for AMP 11/30/11 CF
⑤ GLM for ? 11/30/11 CF

DAILY TOXICITY TEST LOG

cw 10/12/11

Project Number: 60147216-445 (002-007) | Test Species (Circle): D. magna H. azteca C. tentans E. foetida **L. variegatus** Other (Specify): QA: GUM 11/30/11

Test Day	Comments	Feeding (None)	Date & Initials
15	CT = (1) ~~22.4~~ 22.2°C Range 21.8 to 22.6°C	None	NLT 8/3/11
16	CT = 22.4°C Range 21.4 to 23.2°C	None	DM 8/4/11
17	CT = 22.0°C Range 21.4 to 22.2°C	None	AM 8/5/11
18	CT = ~~21.4°C~~ 21.8°C Range ~~21.2 to 22.2°C~~ (2) 21.4 to 22.2°C	None	AP 8/6/11
19	CT = 21.4°C Range 21.2 to 22.2°C	None	AP 8/7/11
20	CT = ~~21.0~~ (5) 21.4°C Range 21.2 to 21.8°C	None	(3) ~~cw~~ cw for AB 8/8/11
21	CT = 21.0°C Range 20.4 to 21.8°C	None	cw 8/9/11
22	CT = 21.8°C Range 21.2 to 22.2°C	None	AM 8/10/11
23	CT = 21.8°C Range 21.2 to 21.8°C	None	cw for AB 8/11/11
24	CT = 21.4°C Range 21.2 to 22.2°C	None	cw for NLT 8/12/11
25	CT = 21.4°C Range 21.2 to 21.8°C	None	AP 8/13/11
26	CT = 21.8°C Range 21.2 to 22.6°C	None	cw for NLT 8/14/11
27	CT = ~~22.8~~ (6) 21.4°C Range ~~22.2~~ 20.8 (6) to ~~23.2~~ 21.8°C (6)	None	AM 8/15/11
28	Composites of waters collected for characterization @ 0900 on 8/15/11 Adults collected from sediment chambers and transferred to clean water @ 8/16 + 8/17 Organisms weighed (unblotted wet weight), transferred to clean sample bottles, and placed in freezer @ 8/17 + 8/18/11 @ ~~0~~ 1700 (4) @ 0800-1700 CT = 21.6°C Range 21.2 to 21.8°C	None	cw 8/16/11

(1) NLT 8/4/11 E (3) cw 08/09/11 WP (5) cw 11/15/11 E
(2) AP 8/7/11 WP (4) cw 10/12/11 E (6) GUM for AMR 11/30/11 CT

cw 10/12/11
QA: GMM 11/10/11

SUBJECT: DAILY LOG

ALL ENTRIES MUST BE INITIALLED WITH DATE AND TIME:

Project Number: 60147216-445-(002-007) observations at test end   8/16/11 @ UNK cw for RBN

formulated A few lumbriculus crawling on sed surface
B few L.V. crawling on sed surface
C few L.V. crawling on sed surface

APG-05/09 A few l.v. visible
B few l.v. visible
C few L.V. visible
} wood/plant material present

APG-04/07 A few lumbriculus visible
B few L.V. visible
C few L.V. visible
} woody/plant material present in sed.

APG 22/23 A Med # of L.V. visible
B med # of L.V. visible
C Med # of L.V. visible

APG 15/21 A lots of L.V. visible
B lots of lumbriculus visible in tubes
C lots of L.V. visible

APG 06/24 A few L.V. visible
B few L.V. visible
C few L.V. visible
} woody/plant material present in sediment

① cw 11/15/11 E

CW 10/12/11
QA: nvm 11/30/11

Study # 6014-~~2116~~-445 (002-007) SUBJECT: DAILY LOG

ALL ENTRIES MUST BE INITIALLED WITH DATE AND TIME: 8/16/11

Sediment	Replicate	Start Time	End Time	Initials	~~Time placed in vials~~	~~Initials~~ ⑥
Formulated Sediment	A	0825/1530	1130 /1625	JK/AP		
	B	1135; 1305	1200; 1730	AS		
	C	1350 /1500	~~2~~ ③ 1453 /1610	JM/~~AP~~		
APG-05/09	A	① ~~09~~ 1035	1435			
	B	1035-1310, 1330 - 1410		AR		
	C	1415	1800	AR		
APG-04/07	A	0825 /1615	1135 / 1815	CW /~~AP~~		
	B	1430	1845	R3N		
	C	1145/~~1350~~ 1358 ⑤	1245/1830	Am KB	~~1830~~ ④	~~KB~~ ④
APG-22/23	A	1010 /1630	1800 / 1835	NLT/AP		
	B	1145/1315	1245/1830	CW		
	C	1500	1845	NLT		
APG-15/21	A	1455	1700	AS		
	B	0825	1130	Am		
	C	1400	1845	DM		
APG-06/24	A	0825	1125	AG		
	B	1130; 1305	1200; 1830	JK		
	C	1015	1325	R3N		

① 8/16/11 E
② Am 8/16/11 E
③ JM 8/16/11 E
④ KB 8/16/11 E
⑤ CW for DC 11/15/11 CF
⑥ CW 11/15/11 E

APPENDIX C

Test Round 2 Laboratory Data Sheets

TOXICITY DATA PACKAGE COVER SHEET

cw 10/12/11
QA: GLM 12/1/11

Test Type: Chronic

Project Number: 60147216-445-~~003~~ (008-012) ②

Test Substance: Sediment

Species: *Lumbriculus variegatus*

Overlying Water Type: Filtered Horsetooth water

Organism Lot or Batch Number: 11-018

Concurrent Control Sediment Type: Formulated Sediment

Age: adult (adult) Supplier: Bayou Aquatics

Date and Time Test Began: 7/26/11 @ 1430-1500

Date and Time Test Ended: 8/23/11/8/24 @ 0730-1800/0745-1930

Protocol Number: USEPA (2000)

Investigator(s): AM/ABS/NLT/CW/KE/AB/AP/KB/DM

Background Information

Type of Test: Continuous Drip Renewal

pH Control?: Yes No If Yes, give % CO_2: N/A

Test Temperature: 23 ± 1 °C

Env. Chmbr/Bath #: ① 43 Test Chambers: 2.5 gal glass aquaria

Test Sediment Vol.: 1000 ml Overlying Water Volume: ~2 L Number of Replicates per Treatment: 3

Length of Test: 28 days Number of Organisms per Replicate: to maintain > 5:1 sediment organic carbon:org. dry weight

Type of Food and Quantity per Chamber: None Feeding Frequency: NA

Photoperiod: 16h Light : 8h Dark Light Intensity: 9.3-93 ft-c.

Overlying Water Characterization Parameters and Frequency: Hardness: Day 0,7,14,21,27 Alkalinity: Day 0,7,14,21,27

NH_3: Day 0,7,14,21, ~~17~~ ① 27 pH: Day 0,7,14,21, ~~17~~ ① 27 Conductivity: Day 0,7,14, 21,27 TRC: NA

Test Concentrations: Formulated Sediment, APG-02/08, APG-11/13, APG-14/10, APG-12/20, and APG-01/03

Reference Toxicant Data:	Test Dates: NA to —	LC50 or IC25 (Circle):	—
Hist. 95% Control Limits: NA to —		Method for Determining Ref. Tox. Value:	—

Special Procedures and Considerations:
Sediments will be homogenized before use in testing.
Hard/alk, pH, cond, and NH_3 of the overlying water will be measured on days 0, 7, 14, 21, and 27
DO will be measured daily and is to be maintained at ≥2.5 mg/L
Overlying water renewal rate at approximately 2 volume additions (4000 ml) per day, or ~~2.3~~ ~2.8 ③ ml/min

Study Director Initials: LZN	Date: 7/25/11

①CW 07/25/11 E ②CW 10/12/11 E ③CW 11/15/11 CF

SEDIMENT/SOIL PREPARATION

Project Number: 60147216-445-(008-012)

CN 10/12/11

QA: GKM 11/10/11

Artificial soil	
Constituent/source	**Amount added (g)**
Rinsed Medium Grit Silica Sand	8500
Clay/Silt Mixture (ASP 400)	1500
Dolomite	5
Humic Acid (Sodium Salt) (Lot #C10-034)	1
Sieved Sphagnum Moss	220
Calcium Carbonate (Lot #C02-064)	109

Notes: Medium grit silica sand was rinsed with deionized water and baked overnight in 105°C oven prior to sediment mixing.
Sphagnum Moss was sieved using a 2 mm sieve prior to mixing. Calcium carbonate added to raise soil pH from 3.4 to final pH of 6.8.

Soil/sediment	FCETL#	Homogenization			
		Date	**From**	**To**	**Analyst**
Form. Sed	N/A	7/25/11	0933	0936	CN
APG-02/08	24816	7/25/11	1023	1026	AM
APG-11/13	24810	7/25/11	1008	1011	CN
APG-14/10	24814	7/25/11	0941	0944	AM
APG-12/20	24811	7/25/11	1058	1101	AM
APG-01/03	24817	7/25/11	1043	1045	CN

QA: GMM 12/1/11

SUBJECT: DAILY LOG

ALL ENTRIES MUST BE INITIALLED WITH DATE AND TIME:

Preparation of 3% organic Laboratory Formulated Sediment 5/27/11 @1530

- Rinsed ~10L Medium grit silica sand with deionized water until rinse water was clear. Placed rinsed sand in baking dishes and baked overnight in 105°C oven. Sand was removed from oven and allowed to cool prior to mixing.

- Mixed together the following materials in a ~~10~~ 5 gal clean bucket:
  - Rinsed + baked Medium grit silica sand - 8500 g
  - Clay/silt mixture (ASP 400) - 1500 g
  - Dolomite - 5 g
  - Humic Acid (Lot# C10-034) - 1 g
  - Sieved (using 2 mm sieve) sphagnum moss - 220 g
- Mixture was shaken for ~15 min to thoroughly ~~to~~ combine materials.

Soil pH - 3.4

6/29/11 CW
- Added 108.9 g $CaCO_3$ (Lot# C02-064) to ~24 lbs formulated Sediment to raise the soil pH.

Soil pH - 6.8

OCW 5/27/11 E

BIOLOGICAL DATA

CW 10/12/11

Project Number: 60147216-445-~~003~~(008-012)	Test Species (Circle): H. azteca C. tentans E. foetida **L. variegatus** Other (Specify): QA: GLM 12/1/11

Treatment / Sediment	Rep.	Initial: Wet Weight Unblotted worms (g)[a]	Initial: Calculated Wet Weight Blotted Worms[b]	Initial: Calculated Dry Weight Worms[c]	Initial: Sediment Organic:Dry Worm Weight Ratio[d]	Final: Wet Weight Unblotted Worms (g)[a,e]
Form. Sed	A	2.6				1.5
	B	2.5				0.4
	C	2.6				1.5
APG-02/08	A	6.7				1.4
	B	6.7				1.9
	C	6.7				2.3
APG-11/13	A	6.7				4.5
	B	6.7				2.5 + 1.4
	C	6.7				1.5
APG-14/10	A	6.7				1.7 + 1.2
	B	6.7				3.7
	C	6.7				3.9
APG-12/20	A	6.7				2.8
	B	6.7				4.6
	C	6.7				1.6
APG-01/03	A	6.7				2.0
	B	6.7				2.6
	C	6.7				1.5
Date		7/26/11				8/24/11 - 8/25/11
Time		1430 - 1500				0825-1620 + 0800-1130
Analyst		AS/NGT				CW

[a] Measured Using Balance Number AND Top Loader
[b] Unblotted wet weight of worms divided by 1.33
[c] Ratio applied to unblotted wet weight of worms : 0.117
[d] Sediment organic content calculated NA
[e] Organisms depurated from 7/23/11 + 7/24/11 @ ~~1400~~ 1800 + 1930 to ~~1700~~ 7/24/11 + 7/25/11 @ 0800 (date/time) in HT water / 500 mL beakers (water/holding vessel)

① CW 10/12/11 E ④ CW 11/15/11 CF

QA 10/12/11
QA: GMM 11/10/11

BIOLOGICAL DATA

Project Number: 60147216-445-(① ~~002-007,~~ 008-012)

Test Species: *Lumbriculus variegatus*

Sample Name	Rep	Initial: Wet Weight of Unblotted Worms (g)	Initial: Est. Blot Dry Wt. of Worms Added (g)[a]	Initial: Est. Dry Wt. of Worms Added (g)[a]	Final: Wet Weight of Unblotted Worms (g)	Final: % Recovery
Form Sed	A	2.6	1.95	0.23	1.5	58%
	B	2.5	1.88	0.22	0.4	16%
	C	2.6	1.95	0.23	1.5	58%
APG-02/08	A	6.7	5.04	0.59	1.4	21%
	B	6.7	5.04	0.59	1.9	28%
	C	6.7	5.04	0.59	2.3	34%
APG-11/13	A	6.7	5.04	0.59	4.5	67%
	B	6.7	5.04	0.59	3.9	58%
	C	6.7	5.04	0.59	1.5	22%
APG-14/10	A	6.7	5.04	0.59	2.9	43%
	B	6.7	5.04	0.59	3.7	55%
	C	6.7	5.04	0.59	3.9	58%
APG-12/20	A	6.7	5.04	0.59	2.8	42%
	B	6.7	5.04	0.59	4.6	69%
	C	6.7	5.04	0.59	1.6	24%
APG-01/03	A	6.7	5.04	0.59	2.0	30%
	B	6.7	5.04	0.59	2.6	39%
	C	6.7	5.04	0.59	1.5	22%

[a] Calculated by dividing unblotted wet weight by 1.33 (USEPA, 2000) to obtain blotted wet weight and then multiplying estimated blotted wet weight by 0.117 (wet weight to dry weight conversion calculated by FCETL during previous studies)

Note: Values are rounded to two digits; some slight differences may be found when applying conversion factors to rounded values

① GMM for? 11/10/11 CF

CHEMICAL DATA

CW 10/12/11

Project Number: 60147216-445-~~003~~ (008-012)	Test Species (Circle): D. magna H. azteca C. tentans E. foetida **L. variegatus**	Other (Specify):	QA: GMM 11/10/11

Test sediment	pH							Dissolved Oxygen (mg/L)							Temperature						
	Test day							Test day							Test day						
	0	1	2	3	4	5	6	0	1	2	3	4	5	6	0	1	2	3	4	5	6
Form Sed	8.3	8.1	8.0	8.0	7.9	8.0	8.1	6.8	4.9	6.1	6.2	5.8	5.9	5.8	22	22	22	22	22	23	22
APG-02/08	7.4	7.3	7.4	7.6	7.7	7.5	7.6	5.9	4.5	6.2	6.0	5.0	5.4	5.8	22	22	22	22	22	23	22
APG-11/13	7.5	7.3	7.1	7.3	7.4	7.3	7.3	6.5	4.8	5.4	5.4	4.2	5.3	5.0	22	22	22	22	22	23	22
APG-14/10	7.6	7.3	7.3	7.5	7.3	7.4	7.4	6.7	4.8	5.7	5.8	4.2	4.9	4.8	22	22	22	22	22	23	22
APG-12/20	7.6	7.3	7.4	7.4	7.3	7.4	7.5	6.2	4.9	5.7	5.0	4.5	4.6	4.6	22	22	22	22	22	23	23
APG-01/03	7.5	7.4	7.4	7.4	7.3	7.5	7.5	6.5	5.0	5.8	5.4	4.9	5.2	4.9	22	22	22	22	22	23	23
Replicate	A	B	C	A	B	C	A	A	B	C	A	B	C	A	A	B	C	A	B	C	A
Meter	16	16	16	16	16	16	16	5	5	5	5	5	5	5	D41	D41	D41	D41	D41	D41	D41
Date	7/26/11	7/27/11	7/28/11	7/29/11	7/30/11	7/31/11	8/1/11	7/26/11	7/27/11	7/28/11	7/29/11	7/30/11	7/31/11	8/1/11	7/26/11	7/27/11	7/28/11	7/29/11	7/30/11	7/31/11	8/1/11
Time	1400	1050	1045	1505	1430	1530	1115	1400	1050	1045	1505	1430	1530	1115	1400	1045	1045	1505	1435	1530	1115
Initials	NLT	KB	NLT	DM	AB	AB	AB	NLT	KB	NLT	DM	AB	AB	AB	NLT	KB	NLT	DM	AB	AB	AB

Test sediment	pH							Dissolved Oxygen (mg/L)							Temperature						
	Test day							Test day							Test day						
	7	8	9	10	11	12	13	7	8	9	10	11	12	13	7	8	9	10	11	12	13
Form Sed	8.1	8.1	8.2	8.0	8.1	8.1	8.2	6.0	5.8	6.3	6.0	6.0	6.0	6.1	22	23	23	22	22	22	21
APG-02/08	7.7	8.0	7.8	7.7	7.7	7.7	7.6	5.7	5.8	6.3	5.6	5.0	5.2	5.5	22	23	23	22	22	22	21
APG-11/13	7.3	7.6	7.4	7.3	7.4	7.5	7.4	5.1	5.5	5.4	4.5	5.4	5.4	5.5	22	23	23	22	22	22	21
APG-14/10	7.5	7.5	7.5	7.5	7.4	7.4	7.5	5.2	5.3	5.6	4.8	5.3	5.2	5.2	22	23	23	22	22	22	21
APG-12/20	7.5	7.6	7.7	7.5	7.5	7.4	7.5	4.4	5.5	5.8	4.4	5.3	5.3	5.1	22	23	23	22	22	22	21
APG-01/03	7.5	7.6	7.6	7.5	7.5	7.5	7.4	5.1	5.1	5.8	5.1	5.7	5.7	5.6	22	23	23	22	22	22	21
Replicate	B	C	A	B	C	A	B	B	C	A	B	C	A	B	B	C	A	B	C	A	B
Meter	16	16	16	16	16	16	16	5	5	5	5	5	5	5	D41	D41	D41	D41	D41	D41	D41
Date	8/2/11	8/3/11	8/4/11	8/5/11	8/6/11	8/7/11	8/8/11	8/2/11	8/3/11	8/4/11	8/5/11	8/6/11	8/7/11	8/8/11	8/2/11	8/3/11	8/4/11	8/5/11	8/6/11	8/7/11	8/8/11
Time	0910	1545	1155	0855	1455	1355	1105	0910	1545	1155	0855	1500	1355	1105	0910	1545	1040	0855	1500	1350	1105
Initials	CW	NLT	DM	AMR	AP	AP	AB	CW	NLT	DM	AMR	AP	AP	AB	CW	NLT	DM	AMR	AP	AP	AB

① KB 7/27/11 E ④ CW for NLT 11/2/11 E

③ AB 8/1/11 E

③ CW 10/12/11 E

CHEMICAL DATA

cw 10/12/11

Project Number: ~~60147216-445-003~~ ⑤ (008-012) | Test Species (Circle): D. magna H. azteca C. tentans E. foetida **L. variegatus** | Other (Specify): QA-GAM 11/10/11

Test sediment	pH							Dissolved Oxygen (mg/L)							Temperature						
	Test day							Test day							Test day						
	14	15	16	17	18	19	20	14	15	16	17	18	19	20	14 ▲	15	16	17	18	19	20
Form Sed	8.1	7.5	8.0	8.0	8.3	8.3	8.1	6.1	6.0	6.0	6.0	5.8	5.8	6.3	21	22	21	21	21	21	21
APG-02/08	7.6	7.5	7.7	7.8	7.4	7.5	7.6	5.5	5.5	5.6	6.4	5.0	5.7	5.6	21	22	21	21	21	21	21
APG-11/13	7.4	7.4	7.4	7.1	7.3	7.4	7.2	5.5	4.4	5.7	4.8	5.1	5.1	5.1	21	22	21	21	21	21	21
APG-14/10	7.5	7.5	7.4	7.5	7.3	7.4	7.2	5.1	4.7	5.7	4.7	3.8	3.8	4.8	21	22	21	21	21	21	21
APG-12/20	7.6	7.5	7.5	7.6	7.4	7.3	7.4	5.2	4.2	4.8	4.9	4.2	4.0	4.6	21	22	21	21	21	21	21
APG-01/03	7.5	7.5	7.5	7.6	7.4	7.4	7.5	5.3	4.8	5.0	5.4	4.8	4.6	5.9	21	22	21	21	21	21	21
Replicate	C	A	B	C	A	B	C	C	A	B	C	A	B	C	C	A	B	C	C	B	B
Meter	16	16	16	16	16	16	16	5	5	6	5	6	6	5	D41	D41	D41	D41	D41	D41	D41
Date	8/9/11	8/10/11	8/11/11	8/12/11	8/13/11	8/14/11	8/15/11	8/9/11	8/10/11	8/11/11	8/12/11	8/13/11	8/14/11	8/15/11	8/9/11	8/10/11	8/11/11	8/12/11	8/13/11	8/14/11	8/15/11
Time	0900	1030	0910	1610	1740	1210	0940	0900	1030	0910	1610	1740	1210	0940	0900	1030	0910	1610	1740	1210	0910
Initials	cw	AM	AB	NLT	[illegible]	NLT	AB	cw	AM	AB	NLT	[illegible]	NLT	AB	cw	AM	AB	NLT	[illegible]	NLT	AB

Test sediment	pH							Dissolved Oxygen (mg/L)							Temperature						
	Test day							Test day							Test day						
	21	22	23	24	25	26	27	21	22	23	24	25	26	27	21	22	23	24	25	26	27
Form Sed	8.0	8.0	8.1	7.9	8.0	8.1	8.0	5.9	6.0	6.1	6.2	5.6	6.2	5.9	22	22	21	21	21	22	21
APG-02/08	7.6	7.5	7.5	7.5	7.8	7.6	7.5	② 5.3	5.3	5.3	5.6	5.4	5.6	5.0	22	22	21	21	21	22	21
APG-11/13	7.4	7.4	7.3	7.3	7.5	7.3	7.0	4.8	4.7	5.1	5.6	4.3	5.4	4.7	22	22	21	21	21	22	21
APG-14/10	7.5	7.3	7.3	7.3	7.3	7.3	7.3	5.2	4.6	4.9	5.3	4.4	5.1	4.7	22	22	21	21	21	22	21
APG-12/20	7.5	7.3	7.3	7.3	7.4	7.3	7.4	4.8	4.1	4.0	5.6	4.0	5.1	4.4	22	22	21	21	21	22	21
APG-01/03	7.5	7.3	7.3	7.3	7.4 ④	7.4	7.4	5.2	4.9	4.7	5.2	4.8	5.6	5.2	22	22	21	21	21	22	21
Replicate	A	B	C	A	B	C	A	A	B	C	A	B	C	A	~~D41~~ A ②	~~D41~~ B ③	C	A	B	C	A
Meter	16	16	16	16	16	16	16	5	5	5	5	5	5	5	~~8/16/11~~ D41	D41	D41	D41	D41	D41	D41
Date	8/16/11	8/17/11	8/18/11	8/19/11	8/20/11	8/21/11	8/22/11	8/16/11	8/17/11	8/18/11	8/19/11	8/20/11	8/21/11	8/22/11	8/16/11	8/17/11	8/18/11	8/19/11	8/20/11	8/21/11	8/22/11
Time	0905	1450	NR	1610	1550	NR	1050	0905	1450	NR	1610	1550	NR	1050	0910	1450	NR	1610	1550	NR	1050
Initials	KB	KB	AM	AB	KB	cw for BP	AB	KB	KB	AM	AB	KB	cw for BP	AB	KB	KB	AM	AB	KB	cw for BP	AB

▲ Adjusted temperature of bath up ① AM 8/10/11 WP; CF 8.1 ② KB 8/16/11 E ③ KB 8/17/11 E ④ KB 8/20/11 E

⑤ cw 10/12/11 E

CHEMICAL DATA

cw 10/12/11

Project Number: 60147216-445-~~003~~①(008-012)	Test Species (Circle): D. magna H. azteca C. tentans E. foetida **L. variegatus**	Other (Specify): QA: GMM 11/10/11

Test sediment	pH							Dissolved Oxygen (mg/L)							Temperature						
	Test day							Test day							Test day						
	28							28							28						
Form Sed	8.2							6.7							21						
APG-02/08	7.9							6.8							21						
APG-11/13	7.6							6.8							21						
APG-14/10	7.7							6.8							21						
APG-12/20	7.9							6.8							21						
APG-01/03	7.8							6.7							21						
Replicate	B							B							B						
Meter	16							5							D41						
Date	8/23/11							8/23/11							8/23/11						
Time	1145							1145							0710						
Initials	BP							BP							cw						

①cw 10/12/11 E

OVERLYING WATER CHARACTERIZATION

QA: GMM 11/10/11
cw 10/12/11

Project Number: 60147216-445-~~003~~ ④ (08-012) | Test Species (Circle): *D. magna* *H. azteca* *C. tentans* *E. foetida* ***L. variegatus*** Other (Specify):

Conc.	Hardness (mg/L $CaCO_3$)					Alkalinity (mg/L $CaCO_3$)					Conductivity (µS/cm)					NH_3 (mg/L)				
	0	7	14	21	27	0	7	14	21	27	0	7	14	21	27	0	7	14	21	27
Form Sed	64	80	66	74	86	71	83	66	70	85	162 ~~16230~~ ②	187	160	166	186	<1.0	1.1	<1.0	<1.0	<1.0
APG-02/08	40	74	44	46	50	39	73	46	48	52	147 ~~14700~~ ②	244	123	126	132	<1.0	1.4	<1.0	1.0	<1.0
APG-11/13	40	26	28	32	44	25	30	29	26	18	125 ~~12530~~ ②	150	106	104	91	<1.0	1.7	1.4	1.5	<1.0
APG-14/10	46	68	44	48	44	28	61	48	41	46	164 ~~16360~~ ②	237	143	146	131	<1.0	1.6	<1.0	<1.0	<1.0
APG-12/20	48	86	44	46	60	39	81	51	43	54	313	320	149	132	160	<1.0	2.2	1.5	<1.0	<1.0
APG-01/03	50	78	62	52	54	40	63	59	46	52	172 ~~17160~~ ②	247	182	150	159	<1.0	1.6	1.0	<1.0	<1.0
Meter#	Titr	Titr	Titr	Titr	Titr	Titr	Titr	Titr	Titr	Titr	15	15	15	15	15	HA#1	HA#1	HA#1	HA#1	HA#1
Date:	7/26 ~~27~~/11 ④	8/2/11	8/9/11	8/16/11	8/22/11	7/26 ~~27~~/11 ③	8/2/11	8/9/11	8/16/11	8/22/11	7/26 ~~27~~/11 ③	8/2/11	8/9/11	8/16/11	8/22/11	7/26 ~~27~~/11 ③	8/2/11 ① ~~7/27/11~~	8/9/11	8/16/11	8/22/11
Time:	0930	0900	0840	1000	0920	0930	0900	0840	1000	0920	0930	0900	0840	1000	0920	1300	1420 ~~1300~~ ①	1336	1000	1600
Initials:	NLT	cw for TK	cw for TK	cw for DM	cw for NLT	NLT	cw for TK	cw for TK	cw for DM	cw for NLT	NLT	cw for TK	cw for TK	cw for DM	cw for NLT	cw for NLT	cw for DM ~~NLT~~ ①	cw for NLT	cw for DM	cw for NLT

① cw for NLT 10/12/11 WP
② cw for NLT 10/12/11 E
③ cw 10/12/11 E
④ cw for NLT 11/15/11 CF

DAILY TOXICITY TEST LOG

CW 10/12/11

Project Number: 60147216-445-~~003~~ (2) (008-012)	Test Species (Circle): D. magna H. azteca C. tentans E. foetida **L. variegatus** Other (Specify): QA: GVM 12/1/11

Test Day	Comments Not randomized	Feeding (None)	Date & Initials
-1	Chambers filled with sediments and overlying water placed in test bath @ 0936-1101 Water drip started @ 1130 approx. drip rate = 28 mL/min	None	CW 7/25/11
0	Test Organisms added @ 1430-1500 CT = 22.0°C Range 21.2 to 22.4°C	None	CW 7/26/11
1	CT = 21.8°C Range 21.6 to 22.0°C	None	KB 7/27/11
2	CT = 21.4°C Range 21.2 to 21.6°C	None	CW for NLT 7/28/11
3	CT = 21.2°C Range 21.0 to 21.6°C	None	DM 7/29/11
4	CT = 21.~~5~~6 (3) °C Range 21.2 to 22.0°C	None	7/30/11
5	CT = 21.~~7~~ 6 (3) °C Range 21.~~0~~2 (3) to 22.0°C	None	7/31/11 CW for AS
6	CT = 22.0°C Range 21.6 to 22.4°C	None	8/1/11 CW for AB
7	CT = ~~22.2~~ 21.6 (3) °C Range ~~21.8~~ 21.2 (3) to ~~22.6~~ 22.4°C	None	8/2/11 CW
8	CT = 21.8°C Range 21.6 to 22.0°C	None	8/3/11 CW for NLT
9	CT = 21.8°C Range 21.6 to 22.0°C	None	8/4/11 DM
10	CT = 21.8°C Range 21.6 to 22.4°C	None	8/5/11 AM
11	CT = 21.4°C Range 21.2 to 21.6°C	None	8/6/11 AP
12	CT = 21.2°C Range 21.0 to 21.6°C	None	8/7/11 AP
13	CT = 21.0°C Range 20.6 to 21.2°C	None	(1) ~~CW~~ CW for AB 8/8/11
14	CT = 20.8°C Range 20.2 to 21.2°C	None	CW 8/9/11

(1) CW 08/09/11 E
(2) CW 10/12/11 E
(3) GVM 12/1/11 CF

DAILY TOXICITY TEST LOG

cw 10/12/11

Project Number: ~~60147216-445-003~~ (008-012) | Test Species (Circle): D. magna H. azteca C. tentans E. foetida **L. variegatus** Other (Specify): QA: 6/um 12/1/11

Test Day	Comments	Feeding (None)	Date & Initials
15	CT = 21.2°C Range 21.0 to 21.6°C	None	AM 8/10/11
16	CT = 21.4°C Range 21.0 to 21.6°C	None	cw for AB 8/11/11
17	CT = 21.0°C Range 21.0 to 21.2°C	None	cw for NJT 8/12/11
18	CT = 21.~~4~~0°C (2) Range ~~21.2~~ 20.6 (2) to ~~21.8~~ 21.2°C (2)	None	8/13/11
19	CT = 21.2°C Range 21.0 to 21.6°C	None	cw for NJT 8/14/11
20	CT = 21.0°C Range 21.0 to 21.6°C	None	AM 8/15/11
21	CT = 21.0°C Range 21.0 to 21.2°C	None	8/16/11 KB
22	CT = 20.8°C Range 20.2 to 21.2°C	None	8/17/11 KB
23	CT = 20.8°C Range 20.2 to 21.0°C	None	8/18/11 cw for AMR
24	CT = 20.8°C Range 20.2 to 21.2°C	None	8/19/11 cw for AB
25	CT = 20.6°C Range 20.2 to 21.0°C	None	8/20/11 cw for KB
26	CT = 20.8°C Range 20.2 to 21.2°C	None	8/21/11 DM
27	CT = 21.2°C Range 20.6 to 21.6°C	None	8/22/11 AB
28	Composites of waters collected for characterization @ 1000 on 8/22/11 Adults collected from sediment chambers and transferred to clean water @ 1700 Organisms weighed (unblotted wet weight), transferred to clean sample bottles, and placed in freezer @ 7/24/11 from 0800 to 1700 and 7/25/11 @ 0800 to 1130 CT = 21.0°C Range 20.6 to 21.2°C	None	8/23/11 cw

Form Sed- most orgs buried, some on top of soil
14/10 - orgs buried, water murky
11/13 - orgs evenly distributed, heads out of sed

02/08 - orgs buried
01/03 - orgs buried
12/20 - orgs evenly distributed, heads out of sed

(1) cw 10/12/11 E
(2) AMM 12/1/11 QA

CW 10/12/11
QA: FMM 12/1/11

Test Termination

Project Number: 60147216-445 (008-012)

Sample	Replicate	Start Time	End Time	Initials	
Formulated	A	0730	1255	AB	8/23/11
	B	0820	1116	[illegible]	8/23/11
	C	1425 / 1500	1600 / 1625	[illegible] / AP	8/23/11
APG-02/08	A	0800 / ~~1220~~ 1325	1220 / 1625	AB	8/24/11
	B	1625	1945	CW/AR/AB	8/24/11
	C	0815 / 1124	1210 / 1205	[illegible] / CW	8/23/11
APG-11/13	A	0810	1740	AB	8/23/11
	B	1045 / 0800	1900 / 1220	DM / KB	8/23/11 / 8/24/11
	C	0830	1700	RBN	8/23/11
APG-14/10	A	1440 / 0755, 1420 1700	~~1730~~ 1830 ① / 1220; 1730	AR / ~~AR~~ E / AR	8/23/11 / 8/24/11
	B	0740	1745	R	8/23/11
	C	0900 / ~~1235, 1345 - 1645~~ 1345 ①	1235 / 1645	AR / JM	8/24/11
APG-12/20	A	1550	1930	[illegible] / RBN	8/24/11
	B	0740	1725	CW	8/23/11
	C	0800 / 1300	1220 / 1710	FMM	8/24/11
APG-01/03	A	0130	1850	CW / KB	8/24/11
	B	0125 / 1015 / 1630	1700 / ~~1805~~ / 1805	CW / ~~AC~~ / AP	8/23/11
	C	1115 / 1315	1215 / 1630	R	8/24/11

① AR 08/24/11 E
② AB 08/24/11 WP

APPENDIX D

Chain of Custody Records for Tissue Samples sent to Analytical Laboratory

AECOM

CHAIN OF CUSTODY RECORD

Client/Project Name: 445	Project Location: FCETL | AECOM	Analysis Requested	Container Type: P – Plastic; A – Amber Glass; G – Clear Glass; V – VOA Vial; O – Other; E – Encore. Preservation: 1 – HCl, 4°; 2 – H2SO4, 4°; 3 – HNO3, 4°; 4 – NaOH, 4°; 5 – NaOH/ZnAc, 4°; 6 – Na2S2O3, 4°; 7 – 4°
Project Number: 60147216-445-~~0020~~ (002-007)	Field Logbook No.:		
Sampler (Print Name)/(Affiliation): Christina Needham | AECOM	Chain of Custody Tape Nos.: 40939		Matrix Codes: DW – Drinking Water; WW – Wastewater; GW – Groundwater; SW – Surface Water; ST – Storm Water; W – Water; S – Soil; SL – Sludge; SD – Sediment; SO – Solid; A – Air; L – Liquid; P – Product
Signature: Christina Needham	Send Results/Report to: Rami Naddy	TAT: Std	

Field Sample No./Identification	Date	Time	COMP	GRAB	Sample Container (Size/Mat'l)	Matrix	Preserv.	Field Filtered	PCB Analysis										Lab I.D.	Remarks
Form Sed A	8/17/11	1000		X	20mL vial	Tissue	ice		X											
Form Sed B	8/17/11	0930																		
Form Sed C	8/17/11	1000																		
APG-05/09 A	8/17/11	1350																		
APG-05/09 B	8/17/11	1410																		
APG-05/09C	8/17/11	1435																		
APG-04/07A	8/17/11	1230																		
APG-04/07B	8/17/11	1115																		
APG-04/07 C	8/17/11	1230																		
APG-22/23A	8/17/11	1115																		
APG-22/23 B	8/17/11	1050																		
APG-22/23C	8/17/11	1006																		
APG-15/21 A	8/17/11	1515																		

Relinquished by: (Print Name)/(Affiliation) Christina Needham | AECOM. Signature: Christina Needham	Date: 8/22/11 Time: 1200	Received by: (Print Name)/(Affiliation) Signature:	Date: Time:	Analytical Laboratory (Destination): ~~AECOM Toxicology Lab 4303 W. Laporte Avenue Fort Collins, CO 80521 (970) 416-0916 (970) 490-2963 (FAX)~~ University of New Hampshire
Relinquished by: (Print Name)/(Affiliation) Signature:	Date: Time:	Received by: (Print Name)/(Affiliation) Signature:	Date: Time:	
Relinquished by: (Print Name)/(Affiliation) Signature:	Date: Time:	Received by: (Print Name)/(Affiliation) Signature:	Date: Time:	Sample Shipped Via: UPS FedEx Courier Other. Temp blank: Yes No

GW 12/01/11 CF

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Serial No. № 51541

AECOM

CHAIN OF CUSTODY RECORD

Client/Project Name: 445	Project Location: FCETL | AECOM
Project Number: 60147216-445® ~~002~~ (002-007)	Field Logbook No.:
Sampler (Print Name)/(Affiliation): Christina Needham | AECOM	Chain of Custody Tape Nos.: 40939
Signature: Christina Needham	Send Results/Report to: Rami Naddy; TAT: std

Container Type: P – Plastic; A – Amber Glass; G – Clear Glass; V – VOA Vial; O – Other; E – Encore

Preservation: 1 – HCl, 4°; 2 – H2SO4, 4°; 3 – HNO3, 4°; 4 – NaOH, 4°; 5 – NaOH/ZnAc, 4°; 6 – Na2S2O3, 4°; 7 – 4°

Matrix Codes: DW – Drinking Water; WW – Wastewater; GW – Groundwater; SW – Surface Water; ST – Storm Water; W – Water; S – Soil; SL – Sludge; SD – Sediment; SO – Solid; A – Air; L – Liquid; P – Product

Analysis Requested

Field Sample No./Identification	Date	Time	COMP	GRAB	Sample Container (Size/Mat'l)	Matrix	Preserv.	Field Filtered	PCB Analysis										Lab I.D.	Remarks
APG-15/21 B	8/17/11	1340		X	20mL vial	Tissue	ice		X											
APG-15/21 C	8/17/11	1205		↓	↓	↓	↓		↓											
APG-06/24 A	8/17/11	1330		↓	↓	↓	↓		↓											
APG-06/24 B	8/17/11	1430		↓	↓	↓	↓		↓											
APG-06/24 C	8/17/11	1035		↓	↓	↓	↓		↓											
Lot # 11-017 @ Test initiation	7/19/11	unk		↓	↓	↓	↓		↓											
Lot # 11-017 (upon receipt)	7/1/11	unk		↓	↓	↓	↓		↓											

Relinquished by: (Print Name)/(Affiliation)	Date/Time	Received by: (Print Name)/(Affiliation)	Date/Time
Christina Needham | AECOM; Signature: Christina Needham	Date: 8/22/11; Time: 1200	Signature:	Date: ; Time:
Signature:	Date: ; Time:	Signature:	Date: ; Time:
Signature:	Date: ; Time:	Signature:	Date: ; Time:

Analytical Laboratory (Destination):
~~AECOM Toxicology Lab~~
~~4303 W. Laporte Avenue~~
~~Fort Collins, CO 80521~~
~~(970) 416-0916~~
~~(970) 490-2963 (FAX)~~
University of New Hampshire

Sample Shipped Via: UPS FedEx Courier Other

Temp blank: Yes No

Ocw 12/01/11 CF

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Serial No. № 51542

AECOM

CHAIN OF CUSTODY RECORD

Client/Project Name: 445

Project Location: FCETL/AECOM

Project Number: 60147216-445 ~~0003~~ (008-012)

Field Logbook No.:

Sampler (Print Name)/(Affiliation): Christina Needham/AECOM

Chain of Custody Tape Nos.: 42505

Signature: Christina Needham

Send Results/Report to: Rami Naddy

TAT: Std

Analysis Requested: PCB Analysis

Field Sample No./Identification	Date	Time	COMP	GRAB	Sample Container (Size/Mat'l)	Matrix	Preserv.	Field Filtered	PCB Analysis	Lab I.D.	Remarks
Lot # 11-018	7/26/11	unk		X	30mL vial	Tissue	ice		X		
Form Sed A	8/24/11	0825		↓	20 mL vial	↓	↓		↓		
Form Sed B	8/24/11	0850		↓	↓	↓	↓		↓		
Form Sed C	8/24/11	0925		↓	↓	↓	↓		↓		
APG-02/08 A	8/25/11	0945		↓	↓	↓	↓		↓		
APG-02/08 B	8/25/11	0910		↓	↓	↓	↓		↓		
APG-02/08 C	8/24/11	1010		↓	↓	↓	↓		↓		
APG-11/13 A	8/24/11	1055		↓	↓	↓	↓		↓		
APG-11/13 B	8/24/11	1130		↓	↓	↓	↓		↓		
APG-11/13 C	8/24/11	1200		↓	↓	↓	↓		↓		
APG-14/10 A	8/24/11	1445		↓	↓	↓	↓		↓		
APG-14/10 B	8/24/11	1515		↓	↓	↓	↓		↓		
APG-14/10 C	8/25/11	0950		↓	↓	↓	↓		↓		

Container Type: P – Plastic; A – Amber Glass; G – Clear Glass; V – VOA Vial; O – Other; E – Encore

Preservation: 1 – HCl, 4°; 2 – H2SO4, 4°; 3 – HNO3, 4°; 4 – NaOH, 4°; 5 – NaOH/ZnAc, 4°; 6 – Na2S2O3, 4°; 7 – 4°

Matrix Codes: DW – Drinking Water; WW – Wastewater; GW – Groundwater; SW – Surface Water; ST – Storm Water; W – Water; S – Soil; SL – Sludge; SD – Sediment; SO – Solid; A – Air; L – Liquid; P – Product

Relinquished by: (Print Name)/(Affiliation)	Date/Time	Received by: (Print Name)/(Affiliation)	Date/Time
Christina Needham/AECOM Signature: Christina Needham	Date: 8/29/11 Time: 1200	 Signature:	Date: Time:
 Signature:	Date: Time:	 Signature:	Date: Time:
 Signature:	Date: Time:	 Signature:	Date: Time:

Analytical Laboratory (Destination):
~~AECOM Toxicology Lab~~
~~4303 W. Laporte Avenue~~
~~Fort Collins, CO 80521~~
~~(970) 416-0916~~
~~(970) 490-2963 (FAX)~~
University of New Hampshire

Sample Shipped Via: UPS FedEx Courier Other

Temp blank: Yes No

@cw 12/01/11 cf

Q:\GRAPHICS\FORMS\Chain of Custody (COC)\Chain-of-Custody_Ft. Collins_10_07.doc

Serial No. № 51531

AECOM

CHAIN OF CUSTODY RECORD

Client/Project Name: 445

Project Location: FCETL | AECOM

Project Number: 60147216-445-~~003~~ (008-012)

Field Logbook No.:

Sampler (Print Name)/(Affiliation): Christina Needham | AECOM

Chain of Custody Tape Nos.: 42505

Signature: Christina Needham

Send Results/Report to: Rami Naddy

TAT: Std

Analysis Requested: PCB Analysis

Field Sample No./Identification	Date	Time	COMP	GRAB	Sample Container (Size/Mat'l)	Matrix	Preserv.	Field Filtered	PCB Analysis	Lab I.D.	Remarks
APG-12/20A	8/25/11	1130		X	20 mL Vial	Tissue	Ice		X		
APG-12/20B	8/24/11	1600									
APG-12/20C	8/25/11	1050									
APG-01/03A	8/25/11	1015									
APG-01/03B	8/24/11	1620									
APG-01/03C	8/25/11	1030									

Container Type: P – Plastic; A – Amber Glass; G – Clear Glass; V – VOA Vial; O – Other; E – Encore

Preservation: 1 – HCl, 4°; 2 – H2SO4, 4°; 3 – HNO3, 4°; 4 – NaOH, 4°; 5 – NaOH/ZnAc, 4°; 6 – Na2S2O3, 4°; 7 – 4°

Matrix Codes: DW – Drinking Water; WW – Wastewater; GW – Groundwater; SW – Surface Water; ST – Storm Water; W – Water; S – Soil; SL – Sludge; SD – Sediment; SO – Solid; A – Air; L – Liquid; P – Product

Relinquished by: (Print Name)/(Affiliation)	Date/Time	Received by: (Print Name)/(Affiliation)	Date/Time
Christina Needham / AECOM Signature: Christina Needham	Date: 8/29/11 Time: 1200	Signature:	Date: Time:
Signature:	Date: Time:	Signature:	Date: Time:
Signature:	Date: Time:	Signature:	Date: Time:

Analytical Laboratory (Destination):
~~AECOM Toxicology Lab~~
~~4303 W. Laporte Avenue~~
~~Fort Collins, CO 80521~~
~~(970) 416-0916~~
~~(970) 490-2963 (FAX)~~
University of New Hampshire

Sample Shipped Via: UPS FedEx Courier Other

Temp blank: Yes No

Ocw 12/01/11 CF

C:\GRAPHICS\FORMS\Chain of Custody (COC)\Chain-of-Custody_Ft. Collins_10_07.doc

Serial No. № 51547

AECOM Environment
4303 West LaPorte Avenue, Fort Collins, Colorado, 80521
T 970.416.0916 F 970.490.2963 www.aecom.com

February 10, 2012

Ryan McCarthy
AECOM Environment
250 Apollo Drive
Chelmsford, MA 01824

Subject: Report of Whole-Sediment Bioaccumulation Tests

Dear Mr. McCarthy:

Attached is a copy of the report for the whole-sediment bioaccumulation tests using *Lumbriculus variegatus* conducted from September 7 to October 6, 2011 and September 13 to October 11, 2011. These tests were conducted with sediment samples collected on June 1, 2, and 3, 2011. Please do not hesitate to contact one of us if you have any questions.

Sincerely,

Anita Rehner for Christina Needham

Christina Needham
Data Analyst
christina.needham@aecom.com

Rami B. Naddy, Ph.D.
Study Director / Environmental Toxicologist
rami.naddy@aecom.com

Attachment:

60147216-445-(013-020, 021-025)

Report of a Whole Sediment Bioaccumulation Test using *Lumbriculus variegatus*

For

AECOM Environment
Chelmsford, MA, USA

Prepared by

AECOM Technical Services, Inc.

Fort Collins Environmental Toxicology Lab

December 2011

60147216-445-(013-025)

Report of a Whole-Sediment Bioaccumulation Test using Lumbriculus variegatus

Project IDs: 60147216-445-(013-020, 021-025)
September - October 2011

Sponsor and Laboratory Information

Sponsor	AECOM Environment 250 Apollo Drive Chelmsford, MA 01824
Project Officer	Ryan McCarthy (978) 905-2312
Testing Facility	AECOM Environment Fort Collins Environmental Toxicology Laboratory 4303 West LaPorte Ave. Fort Collins, CO 80521 Fax: (970) 490-2963 State of Florida NELAP Laboratory ID: E87972
Study Director	Rami B. Naddy, Ph.D. (970) 416-0916 email: rami.naddy@aecom.com
Report Author	Christina Needham (970) 416-0916 email: christina.needham@aecom.com

Test Information

Test	Bioaccumulation from whole sediment	
Basis	USEPA (2000) and ASTM (2009)	
Test Dates and Time	September 7, 2011 – October 4, 5, and 6, 2011 September 13, 2011 – October 10 and 11, 2011	
Test Length	~28 days	
Species	*Lumbriculus variegatus*	
Test Material	Whole sediments	
Sediment ID	Sample ID	AECOM Laboratory ID
	APG-02/08	24849
	APG-04/07	24854
	APG-05/09	24852
	APG-10/14	24853
	APG-16/17	24847
	APG-18/19	24851
	APG-20/21	24844
	APG-22/23	24845
	APG-01/03	24843
	APG-06/24	24848
	APG-11/13	24850
	APG-12/15	24846
Control Sediment	3% Organic Laboratory Formulated Sediment	
Overlying water	Filtered Horsetooth Reservoir water	
Test Concentrations	0 (control) and 100% of each test sediment	

Sediment Collection and Receipt

Sample ID	Collection Date and Time	AECOM No.	Date of Receipt	Cooler Temp. at Arrival (°C)
APG-02/08	June 1, 2011 @ 1045	24849	June 9, 2011	14.5
APG-04/07	June 2, 2011 @ 1320	24854		9.6
APG-05/09	June 2, 2011 @ 1130	24852		13.9
APG-10/14	June 3, 2011 @ 0915	24853		14.8
APG-16/17	June 2, 2011 @ 1815	24847		15.1
APG-18/19	June 2, 2011 @ 1700	24851		13.5
APG-20/21	June 3, 2011 @ 1245	24844		13.9
APG-22/23	June 1, 2011 @ 1700	24845		13.4
APG-01/03	June 2, 2011 @ 0930	24843		13.0
APG-06/24	June 1, 2011 @ 1700	24848		14.0
APG-11/13	June 3, 2011 @ 1135	24850		13.7
APG-12/15	June 3, 2011 @ 1030	24846		12.7

Note: See Appendix A for copies of chain of custody records

Laboratory Control Sediment

The control sediment used for all tests was laboratory formulated sediment with an estimated organic content of 3% (by weight). The formulated sediment was prepared by combining the following materials:

Material	Quantity (g) (Percent)
Rinsed Medium Grit Silica Sand	8500 (83.1)
Clay/Silt Mixture (ASP 400)	1500 (14.7)
Dolomite	5 (0.049)
Humic Acid (Sodium Salt)	1 (0.0098)
Sieved Sphagnum Moss	220 (2.15)

Prior to mixing, the sphagnum moss was sieved using a 2 mm sieve. The medium grit silica sand was rinsed with deionized water until the water ran clear and then the sand was baked overnight at 105°C. All ingredients were combined and mixed together for at least 15 minutes. Calcium carbonate was added at approximately 1% (by dry weight) to raise the soil pH from ~3.4 to 6.7. At least 24 hours prior to homogenization, a small amount of filtered Horsetooth reservoir water was added to the necessary amount of formulated sediment and the wetted sediment was held at 4°C in the dark.

Test Dates and Times

Sample ID	Test Round	Test Initiation Date and Time	Test Termination Date and Time
APG-02/08, APG-04/07, APG-05/09, APG-10/14, APG-16/17, APG-18/19, APG-20/21, and APG-22/23	1	September 7, 2011 @ 1030-1120	October 4, 2011 @ 0815-1900, October 5, 2011 @ 0745-1835, October 6, 2011 @ 0745-1830
APG-01/03, APG-06/24, APG-11/13, and APG-12/15	2	September 13, 2011 @ 1000-1030	October 10, 2011 @ 0800-1745, October 11, 2011 @ 0800-1720

Test Sediment Preparation

Sample ID	Date Homogenized	Time Homogenized
Test Round 1		
Control	September 6, 2011	0948-0951
APG-02/08 A		1010-1035
APG-02/08 B		1030-1040
APG-04/07 A		1130-1200
APG-04/07 B		1155-1202
APG-05/09 A		1040-1110
APG-05/09 B		1045-1105
APG-10/14 A		1130-1134
APG-10/14 B		1130-1145
APG-16/17 A		1100-1130
APG-16/17 B		1125-1150
APG-18/19 A		1015-1018
APG-18/19 B		1056-1100
APG-20/21 A		1310-1335
APG-20/21 B		1315-1330
APG-22/23 A		1200-1210
APG-22/23 B		1212-1218
Test Round 2		
Control	September 12, 2011	1015-1018
APG-01/03 A		1010-1040
APG-01/03 B		1045-1105
APG-06/24 A		1045-1049
APG-06/24 B		1103-1107
APG-11/13 A		1132-1136
APG-11/13 B		1148-1152
APG-12/15 A		1115-1120
APG-12/15 B		1135-1150

Note: Per client request, replicates were homogenized and tested separately.

Test Conditions

Type	Bioaccumulation Test with Continuous Renewal of Overlying Water
Overlying Water Delivery System	Continuous renewal (flow-through)[a]
Test Endpoints	Body residue of chemicals of potential concern[b]
Test Chambers	2.5 gallon glass aquaria
Test Sediment Volume	1000 ml
Overlying Water Volume	2000 ml
Replicates per Treatment	2
Organisms per Replicate	Added by weight (see pages 6 and 7)
Feeding	None
Test Temperature	23 ± 1°C (≤ 3°C differential)[c]
Lighting	Fluorescent, 16 hours light:8 hours dark
Chamber Placement	Non-Randomized
Test Sediment Renewal	None
Test Overlying Water Renewal	Approximately two to three volume additions per test chamber per day

[a] Continuous replacement via a drip system
[b] Results of chemical analysis of worm tissue not reported here
[c] The test temperature during Test Rounds 1 and 2 (measured in the overlying water) fell below the recommended lower limit of 22°C on various days during the studies due to malfunctioning heating/cooling units. In addition, the instantaneous temperature was more than 3ºC lower than the target temperature in all or several treatments on day 1, 2, and 23 of the first round and days 26 and 27 of the second round. It is the study director's best professional judgment that these excursions did not affect the outcome of the test.

Test Organism

Test Rounds 1 and 2	
Species and Lot Number	*Lumbriculus variegatus*, Lot 11-018
Age	Adult
Source	Bayou Aquatics, Ontario, CA

Estimated Sediment Organic Content

In accordance with EPA guidance, the weight of worms added to each test chamber is dependent on the total organic carbon (TOC) content of the sediment. Worms are added at a minimum target ratio of 1 g dry weight of worms to 50 g sediment TOC (USEPA 2000). This ratio was achieved for test sediments, but not for the controls, as TOC values were not known in advance of study initiation. The moisture content and estimated TOC of each test sediment are presented in the following table:

Sample ID	% Moisture (per mass wet)[a]	Vol. of Sediment in each Test Chamber (ml)	Approx. Sediment Density (g/ml wet)[b]	Approx. Wet Wt. (g) of Sediment in each Test Chamber[c]	Approx. Dry Wt. (g) of Sediment in each Test Chamber[d]	Approx. %TOC (by dry wt.)[a,e]	Estimated TOC (g) in each Test Chamber[f]
APG-02/08	63.22	1000	1.07	1070	394	18.2	71.7
APG-04/07	72.84	1000	1.05	1050	285	14.7	41.9
APG-05/09	62.98	1000	1.24	1240	459	16.7	76.6
APG-10/14	48.53	1000	1.15	1150	592	11.2	66.3
APG-16/17	70.52	1000	1.10	1100	324	21.1	68.4
APG-18/19	67.85	1000	1.01	1010	325	14.6	47.4
APG-20/21	56.95	1000	1.09	1090	469	26.8	126
APG-22/23	62.79	1000	1.09	1090	406	18.1	73.5
APG-01/03	46.62	1000	1.11	1110	592	10.3	61.0
APG-06/24	64.38	1000	1.08	1080	385	16.3	62.8
APG-11/13	71.37	1000	1.10	1100	315	Unk[g]	Unk[g]
APG-12/15	75.25	1000	0.99	990	245	17.2	42.1

[a] Measured by the Environmental Research Group at The University of New Hampshire (Durham, NH)
[b] Measured at the FCETL on November 29, 2011 on each test sediment
[c] Calculated by multiplying volume of sediment in each test chamber by sediment density
[d] Calculated by multiplying Approx. Wet Wt. by [(100-% Moisture)/100]
[e] Calculated by averaging the % TOC values of the two sites composited for each sample
[f] Calculated using the dry weight per test chamber and approximate % TOC
[g] Unknown. TOC was not measured for site APG-11, so approximate % TOC and Estimated TOC could not be determined
Note: Values are rounded to one digit; some slight differences may be found when applying conversion factors to rounded values

TEST RESULTS

Weight of Worms Added and Removed From Test Chambers – Test Round 1

Sample ID	Rep.	Wet Wt. (unblotted) of Worms Added (g)	Est. Dry Wt. of Worms Added (g)[a,b]	Approx. TOC:Dry Worm Wt. Ratio	Wet. Wt. (unblotted) of Worms Recovered (g)	Percent Recovery
Control	A	2.7	0.24	21:1[c]	1.4	52%
	B	2.7	0.24	21:1[c]	1.5	56%
APG-02/08	A	9.0	0.79	91:1	3.0	33%
	B	9.0	0.79	91:1	3.0	33%
APG-04/07	A	9.0	0.79	53:1	4.6	51%
	B	9.0	0.79	53:1	4.2	47%
APG-05/09	A	9.0	0.79	97:1	3.0	33%
	B	9.0	0.79	97:1	3.6	40%
APG-10/14	A	9.0	0.79	84:1	4.9	54%
	B	9.0	0.79	84:1	2.2	24%
APG-16/17	A	9.0	0.79	86:1	3.7	41%
	B	9.0	0.79	86:1	4.0	44%
APG-18/19	A	9.0	0.79	60:1	2.5	28%
	B	9.0	0.79	60:1	3.8	42%
APG-20/21	A	9.0	0.79	159:1	3.0	33%
	B	9.0	0.79	159:1	3.1	34%
APG-22/23	A	9.0	0.79	93:1	3.6	40%
	B	9.0	0.79	93:1	2.9	32%

[a] Calculated by dividing unblotted wet weight by 1.33 (USEPA 2000) to obtain blotted wet weight and then multiplying estimated blotted wet weight by 0.117 (wet weight to dry weight conversion calculated by AECOM during previous studies)
[b] Values are rounded to two digits; some slight differences may be found when applying conversion factors to rounded values
[c] Calculated based on 5 g TOC/1000 ml wet volume determined by AECOM during previous studies.
Note: See Appendix B for Test Data

Weight of Worms Added and Removed From Test Chambers – Test Round 2

Sample ID	Rep	Wet Wt. (unblotted) of Worms Added (g)	Est. Dry Wt. of Worms Added (g)[a,b]	Approx. TOC:Dry Worm Wt. Ratio	Wet. Wt. (unblotted) of Worms Recovered (g)	Percent Recovery
Control	A	2.7	0.24	21:1[c]	1.7	63%
	B	2.7	0.24	21:1[c]	1.6	59%
APG-01/03	A	9.0	0.79	77:1	6.4	71%
	B	9.0	0.79	77:1	4.5	50%
APG-06/24	A	9.0	0.79	79:1	3.9	43%
	B	9.0	0.79	79:1	3.5	39%
APG-11/13	A	9.0	0.79	Unk[d]	3.6	40%
	B	9.0	0.79	Unk[d]	3.3	37%
APG-12/15	A	9.0	0.79	53:1	6.1	68%
	B	9.0	0.79	53:1	5.1	57%

[a] Calculated by dividing unblotted wet weight by 1.33 (USEPA 2000) to obtain blotted wet weight and then multiplying estimated blotted wet weight by 0.117 (wet weight to dry weight conversion calculated by AECOM during previous studies)

[b] Values are rounded to two digits; some slight differences may be found when applying conversion factors to rounded values

[c] Calculated based on 5 g TOC/1000 ml wet volume determined by AECOM during previous studies.

[d] Unknown. Approximate TOC: Dry Worm Wt. Ratio could not be calculated for this treatment since TOC was not measured at site APG-11.

Note: See Appendix C for Test Data

Physical and Chemical Data of Overlying Water

Sample ID	pH	DO (mg/L)	Spec. Cond. (µS/cm)	Temperature (°C)[a]	NH_3-N (mg/L)	Hardness (mg/L as $CaCO_3$)	Alkalinity (mg/L as $CaCO_3$)
Test Round 1							
Control	8.0-8.3	5.7-7.5	144-192	19-23	<1.0	58-106	60-96
APG-02/08	7.3-8.1	4.7-7.0	110-132	19-22	<1.0-1.4	36-50	35-45
APG-04/07	7.2-8.0	3.5-7.0	162-234	19-22	<1.0-2.6	52-64	46-80
APG-05/09	7.3-8.0	3.7-7.0	165-259	19-22	<1.0-1.4	56-86	59-97
APG-10/14	7.1-8.2	3.2-6.9	123-181	19-22	<1.0-2.7	30-38	28-48
APG-16/17	7.1-7.8	3.6-6.9	143-193	19-22	<1.0-2.2	40-54	39-54
APG-18/19	7.1-7.8	3.9-6.9	146-193	19-22	<1.0-1.8	44-56	39-56
APG-20/21	7.3-7.9	4.2-6.9	161-288	19-22	<1.0-1.8	50-88	50-105
APG-22/23	7.1-8.1	4.5-6.9	139-180	19-22	<1.0-2.0	36-44	39-55
Test Round 2							
Control	7.3-8.4	4.9-7.3	134-294	19-24	<1.0	60-130	57-127
APG-01/03	7.2-7.9	3.4-7.4	101-162	18-24	<1.0-2.8	32-50	35-57
APG-06/24	7.1-8.0	4.3-7.4	111-148	18-23	<1.0-1.1	36-46	35-49
APG-11/13	7.2-8.3	4.4-7.4	112-329	18-24	<1.0	36-88	37-94
APG-12/15	7.2-8.0	3.3-7.3	118-247	18-23	<1.0-3.4	38-62	37-55

[a] Temperature in overlying water

Note: Continuous temperature in the water baths ranged from 19.4-24.6°C (Test Round1) and 19.8-24.4°C (Test Round 2).

Depuration Period

At the end of the exposure period (~28 days), all worms were removed from each replicate and were held in separate 500-ml beakers containing Horsetooth Reservoir water overnight to allow clearance of gut contents. The following morning, organisms were cleaned, weighed, and frozen. The samples were shipped (on ice) to the Environmental Research Group at The University of New Hampshire, an independent laboratory located in Durham, New Hampshire, USA for tissue analysis (see Appendix D for chain of custody records for these shipments).

References

ASTM. 2009. Standard Test Methods for Measuring the Toxicity of Sediment-Associated Contaminants with Freshwater Invertebrates. Method E 1688-00a in 2009 Annual Book of ASTM Standards, Section 11, Water and Environmental Technology, Volume 11.06, Biological Effects and Environmental Fate; Biotechnology. American Society of Testing and Materials.

USEPA. 2000. Methods for measuring the toxicity and bioaccumulation of sediment-associated contaminants with freshwater invertebrates. EPA/600/R-99/064. United States Environmental Protection Agency, Washington, DC.

Statement of Procedural Compliance

I certify that this document and all attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of the person or persons who manage the system, or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge, accurate and complete.

Rami B. Naddy, Ph.D.
Study Director

February 9, 2012
Date

Statement of Quality Assurance

The test data were reviewed by the Quality Assurance Unit to assure that the study was performed in accordance with the protocol (if applicable) and standard operating procedures. This report is an accurate reflection of the raw data.

Gina P McNerney
Quality Assurance Unit

February 9, 2012
Date

APPENDIX A

Chain of Custody Records

ENSR | AECOM

CHAIN OF CUSTODY RECORD

Client/Project Name: AECOM - ESTCP Canal Creek Field Demonstration	Project Location: Aberdeen Proving Ground Edgewood, MD - Canal Creek
Project Number: 60133180	Field Logbook No.:
Sampler (Print Name)/(Affiliation): M. Russell, D. Smith / AECOM	Chain of Custody Tape Nos.: Not Used
Signature:	Send Results/Report to: Ryan McCarthy Ryan.McCarthy@aecom.com — TAT:

Analysis Requested

Container Type: P – Plastic; A – Amber Glass; G – Clear Glass; V – VOA Vial; O – Other; E – Encore

Preservation: 1 – HCl, 4°; 2 – H2SO4, 4°; 3 – HNO3, 4°; 4 – NaOH, 4°; 5 – NaOH/ZnAc, 4°; 6 – Na2S2O3, 4°; 7 – 4°

Matrix Codes: DW – Drinking Water; WW – Wastewater; GW – Groundwater; SW – Surface Water; ST – Storm Water; W – Water; S – Soil; SL – Sludge; SD – Sediment; SO – Solid; A – Air; L – Liquid; P – Product

Field Sample No./Identification	Date	Time	COMP	GRAB	Sample Container (Size/Mat'l)	Matrix	Preserv.	Field Filtered	Bioaccumulation	Plant Tissue	Lab I.D.	Remarks (cooler temp D-53)
APG-02/08-060111	6/1/11	1045	X		(2) 2 gallon	SD	4°C	NA	X		24849	14.5°C
APG-06/24-060111	6/1/11	1700	X		↓	SD	4°C	NA	X	~~X~~	24848	14.0°C
APG-22/23-060111	6/1/11	1700	X		↓	SD	4°C	NA	X		24845	13.4°C
APG-01/03-060211	6/2/11	0930	X		↓	SD	4°C	NA	X		24843	13.0°C
APG-05/09-060211	6/2/11	1130	X		↓	SD	4°C	NA	X		24852	13.9°C
APG-04/07-060211	6/2/11	1320	X		↓	SD	4°C	NA	X		24854	9.6°C
APG-18/19-060211	6/2/11	1700	X		↓	SD	4°C	NA	X		24851	13.5°C
APG-16/17-060211	6/2/11	1815	X		↓	SD	4°C	NA	X		24847	15.1°C
APG-10/14-060311	6/3/11	0915	X		↓	SD	4°C	NA	X		24853	14.8°C
APG-12/15-060311	6/3/11	1030	X		↓	SD	4°C	NA	X		24846	12.7°C
APG-11/13-060311	6/3/11	1135	X		↓	SD	4°C	NA	X		24850	13.7°C
APG-20/21-060311	6/3/11	1245	X		↓	SD	4°C	NA	X		24844	13.9°C

Relinquished by: (Print Name)/(Affiliation)	Date/Time	Received by: (Print Name)/(Affiliation)	Date/Time
Michele Russell / AECOM — Signature:	Date: 6/8/11 Time: 1500	Emily Sadler / AECOM — Signature:	Date: 6/9/11 Time: 1015
Relinquished by: (Print Name)/(Affiliation) — Signature:	Date: Time:	Received by: (Print Name)/(Affiliation) — Signature:	Date: Time:
Relinquished by: (Print Name)/(Affiliation) — Signature:	Date: Time:	Received by: (Print Name)/(Affiliation) — Signature:	Date: Time:

Analytical Laboratory (Destination): AECOM - Ft. Collins, CO

Rec'd from FedEx on ice, cooler temps taken

Sample Shipped Via: UPS FedEx Courier Other

Temp blank: Yes No

Serial No. 03026

White: Original (to Lab) Yellow: Lab Pink: Sampler

APPENDIX B

Test Round 1 Laboratory Data Sheets

FCETL QA Form No. 051
Revision 4
Effective 1/96
cw 1/9/12
QA: GMM 01/26/12

TOXICITY DATA PACKAGE COVER SHEET

Test Type: Chronic

Project Number: 60147216-445-(013-020)

Test Substance: Sediment

Species: *Lumbriculus variegatus*

Overlying Water Type: Filtered Horsetooth water

Organism Lot or Batch Number: 11-018

Concurrent Control Sediment Type: Formulated Sediment

Age: adult (adult) Supplier: Bayou Aquatics

Date and Time Test Began: 9/7/11 @ 1030-1120

Date and Time Test Ended: ~~10/4-10/6/11 @ 0800-1830@~~ 10/4/11 @ 0815-1900, 10/5/11 @ 0745-1835, 10/6/11 @ 0745-1830

Protocol Number: USEPA (2000) + ASTM (2007)

Investigator(s): cw/AS/NLF/K/KS/AB/ASM/DM/AK cw for CD/AP/cw/AR/BR/MT/ / cw for RBN

Background Information

Type of Test: Continuous Drip Renewal

pH Control?: Yes **No** If Yes, give % CO_2: N/A

Test Temperature: 23 ± 1 °C

Env. Chmbr/**Bath #**: 4 Test Chambers: 2.5 gal glass aquaria

Test Sediment Vol.: 1000 ml Overlying Water Volume: ~2 L Number of Replicates per Treatment: 2

Length of Test: 28 days Number of Organisms per Replicate: to maintain > 5:1 sediment organic carbon:org. dry weight

Type of Food and Quantity per Chamber: None Feeding Frequency: NA

Photoperiod: 16h Light : 8h Dark Light Intensity: 9.3-93 ft-c.

Overlying Water Characterization Parameters and Frequency: Hardness: Day 0,7,14,21,27 Alkalinity: Day 0,7,14,21,27

NH_3: Day 0,7,14,21,27 pH: Day 0,7,14,21,27 Conductivity: Day 0,7,14, 21,27 TRC: NA

Test Concentrations: Formulated Sediment, APG-02/08, APG-04/07, APG-05/09, APG-10/14, APG-16/17, APG-18/19, APG-20/21, and APG-22/23

Reference Toxicant Data: Test Dates: NA to —	LC_{50} or IC_{25} (Circle): —
Hist. 95% Control Limits: NA to —	Method for Determining Ref. Tox. Value: —

Special Procedures and Considerations:
Sediments will be homogenized before use in testing.
Hard/alk, pH, cond, and NH_3 of the overlying water will be measured on days 0, 7, 14, 21, and 27
DO will be measured daily and is to be maintained at ≥2.5 mg/L
Overlying water renewal rate at approximately 2 volume additions (4000 ml) per day, or ~~2.3~~ ~2.8 ml/min ②
Study Director Initials: RBN Date: 9/6/11

① cw 12/12/11 E
② cw 01/27/12 E

CW 1/9/12
QA: RLM 01/26/12

SEDIMENT/SOIL PREPARATION

Artificial soil	
Constituent/source	**Amount added (g)**
Rinsed Medium Grit Silica Sand	8500
Clay/Silt Mixture (ASP 400)	1500
Dolomite	5
Humic Acid (Sodium Salt) (Lot #C10-034)	1
Sieved Sphagnum Moss	220
Calcium Carbonate (Lot #C02-064)	115 ~~100~~ ①
Notes: Medium grit silica sand was rinsed with deionized water and baked overnight in 105°C oven prior to sediment mixing.	
Sphagnum Moss was sieved using a 2 mm sieve prior to mixing. Calcium carbonate added to raise soil pH from 3.4 to final pH of 6.7.	

Soil/sediment	FCETL#	Homogenization			
		Date	From	To	Analyst
Form. Sed	N/A	09/06/11	0948	0951	CW
APG-02/08 A	24849	09/06/11	1010	1035	TK
APG-02/08 B	24849	09/06/11	1030	1040	AB
APG-04/07 A	24854	09/06/11	1130	1200	AB
APG-04/07 B	24854	09/06/11	1155	1202	CW
APG-05/09 A	24852	09/06/11	1040	1110	TK
APG-05/09 B	24852	09/06/11	1045	1105	DM
APG-10/14 A	24853	09/06/11	1130	1134	CW
APG-10/14 B	24853	09/06/11	1130	1145	TK
APG-16/17 A	24847	09/06/11	1100	1130	AB
APG-16/17 B	24847	09/06/11	1125	1150	DM
APG-18/19 A	24851	09/06/11	1015	1018	CW
APG-18/19 B	24851	09/06/11	1056	1100	CW
APG-20/21 A	24844	09/06/11	1310	1335	DM
APG-20/21 B	24844	09/06/11	1315	1330	TK
APG-22/23 A	24845	09/06/11	1200	1210	AB
APG-22/23 B	24845	09/06/11	1212	1218	CW

Note: Per client request, replicates were homogenized separately as well as tested each replicate separately.

① CW 01/27/12 cf

cw 1/9/12
QA: GLM 01/26/12

SUBJECT: DAILY LOG

ALL ENTRIES MUST BE INITIALLED WITH DATE AND TIME:

Preparation of 3% organic Laboratory Formulated Sediment 8/31/11 @1530 cw

For tests: 60147216-445-(013-020) and (021-025)

- Rinsed ~10L Medium grit silica sand with deionized water until rinse water ran clear. Placed rinsed sand in pyrex baking dishes and baked overnight in 105°C oven. Sand was removed from oven and allowed to cool prior to mixing.

- Mixed together the following materials in a 5 gal bucket:
  - Rinsed + baked medium grit silica sand ~8500g
  - Clay/silt mixture (ASP 400) ~1500g
  - Dolomite ~5g
  - Humic acid (Lot# C10-034) ~1g
  - Sieved (using 2mm sieve) sphagnum moss ~220g
  - Calcium carbonate (Lot# C02-064) ~115g to raise soil pH.

Soil pH - 6.7

①cw 01/27/12 cf

cw 1/9/12
QA: GKM 02/08/12

BIOLOGICAL DATA

Project Number: 60147216-445-(013-020)	Test Species (Circle): H. azteca C. tentans E. foetida **L. variegatus** Other (Specify):

Treatment / Sediment	Rep.	Initial: Wet Weight Unblotted worms (g)[a]	Initial: Calculated Wet Weight Blotted Worms[b]	Initial: Calculated Dry Weight Worms[c]	Initial: Sediment Organic:Dry Worm Weight Ratio[d]	Final: Wet Weight Unblotted Worms (g)[a,e]
Form. Sed (Control)	A	① ~~9.0~~ 2.7	②			1.4
	B	2.7				0.5 + 1.0
	C	—				—
APG-02/08	A	9.0				3.0
	B	9.0				3.0
	C	—				—
APG-04/07	A	9.0				4.6
	B	9.0				4.2
	C	—				—
APG-05/09	A	9.0				3.0
	B	9.0				3.6
	C	—				—
APG-10/14	A	9.0				4.9
	B	9.0				2.2
	C	—				—
APG-16/17	A	9.0				3.7
	B	9.0				4.0
	C	—				—
Date		9/7/11				10/5 - 10/7/11 ③
Time		1030-1120				~0800 - 1720 ③
Analyst		~~AS~~ NLT				cw

~~10/4/11 @ 0815-1900~~
③ ~~10/5/11 @ 0745-1835~~
~~10/6/11 @ 0745-1830~~

[a] Measured Using Balance Number AND top Loader
[b] Unblotted wet weight of worms divided by 1.33
[c] Ratio applied to unblotted wet weight of worms : 0.117
[d] Sediment organic content calculated NA
[e] Organisms depurated from 10/4, 10/5, + 10/6/11 @ ~1700 to 10/5, 10/6, + 10/7/11 @ ~0800 (date/time) in horsetooth water | 500 ml beakers (water/holding vessel)

② cw 02/08/12 NA ③ GKM 02/09/12 CF, WP
① AS 9/7/11 E

CW 11/9/12
QA2 GMM 02/08/12

BIOLOGICAL DATA

Project Number: 60147216-445-(013-020)	Test Species (Circle): H. azteca C. tentans E. foetida **L. variegatus** Other (Specify):

Treatment / Sediment	Rep.	Initial: Wet Weight Unblotted worms (g)[a]	Initial: Calculated Wet Weight Blotted Worms[b]	Initial: Calculated Dry Weight Worms[c]	Initial: Sediment Organic:Dry Worm Weight Ratio[d]	Final: Wet Weight Unblotted Worms (g)[a,e]
APG-18/19	A	9.0				2.5
	B	9.0				3.8
	C	—				—
APG-20/21	A	9.0				3.0
	B	9.0				3.1
	C	—				① ~~3.6~~ —
APG-22/23	A	9.0				① ~~2.9~~ 3.6
	B	9.0				2.9
	C	—				—
	A					
	B					
	C				②	
	A					
	B					
	C					
	A					
	B					
	C					
Date		9/7/11				10/5-10/7/11 ③
Time		1030-1120				~0800-1730 ③
Analyst		~~AB~~ NLT				CW

A ~~10/4/11 @ 0815-1900~~
~~10/5/11 @ 0745-1835~~ ③
~~10/6/11 @ 0745-1830~~

[a] Measured Using Balance Number AND Top Loader
[b] Unblotted wet weight of worms divided by 1.33
[c] Ratio applied to unblotted wet weight of worms : 0.117
[d] Sediment organic content calculated NA
[e] Organisms depurated from 10/4, 10/5, + 10/6 @ ~1700 to 10/5, 10/6, + 10/7 @ ~0800 (date/time) in horsetooth water / 500 ml beakers (water/holding vessel)

① CW 12/12/11 WP
② CW 02/08/12 NA
③ GMM 02/09/12 CF, WP

BIOLOGICAL DATA

CU 12/12/11
QA: GVM 01/26/12

Project Number: 60147216-445-(013-020)

Test Species: *Lumbriculus variegatus*

		Initial			Final	
Treatment/Sediment	Rep	Wet Weight of Unblotted Worms (g)	Est. Blot Dry Wt. of Worms Added (g)[a]	Est. Dry Wt. of Worms Added (g)[a]	Wet Weight of Unblotted Worms (g)	% Recovery
Form Sed (control)	A	2.7	2.03	0.24	1.4	52%
	B	2.7	2.03	0.24	1.5	56%
APG-02/08	A	9.0	6.77	0.79	3.0	33%
	B	9.0	6.77	0.79	3.0	33%
APG-04/07	A	9.0	6.77	0.79	4.6	51%
	B	9.0	6.77	0.79	4.2	47%
APG-05/09	A	9.0	6.77	0.79	3.0	33%
	B	9.0	6.77	0.79	3.6	40%
APG-10/14	A	9.0	6.77	0.79	4.9	54%
	B	9.0	6.77	0.79	2.2	24%
APG-16/17	A	9.0	6.77	0.79	3.7	41%
	B	9.0	6.77	0.79	4.0	44%
APG-18/19	A	9.0	6.77	0.79	2.5	28%
	B	9.0	6.77	0.79	3.8	42%
APG-20/21	A	9.0	6.77	0.79	3.0	33%
	B	9.0	6.77	0.79	3.1	34%
APG-22/23	A	9.0	6.77	0.79	3.6	40%
	B	9.0	6.77	0.79	2.9	32%

[a] Calculated by dividing unblotted wet weight by 1.33 (USEPA, 2000) to obtain blotted wet weight and then multiplying estimated blotted wet weight by 0.117 (wet weight to dry weight conversion calculated by FCETL during previous studies)

Note: Values are rounded to two digits; some slight differences may be found when applying conversion factors to rounded values

cw 1/9/12
QA-GWM 01/26/12

CHEMICAL DATA

Project Number: 60147216-445-(013-020) | Test Species (Circle): *D. magna* *H. azteca* *C. tentans* *E. foetida* **L. variegatus** Other (Specify):

Test sediment	pH Test day A 0	1	2	3	4	5	6	Dissolved Oxygen (mg/L) Test day A 0	1	2	3	4	5	6	Temperature (°C) Test day A 0	1	2	3	4	5	6
Form Sed	8.3	8.1	8.1	8.1	8.1	8.0	8.1	6.9	6.2	6.9	6.2	6.2	6.4	6.3	20	19	19	21	21	21	21
APG-02/08	7.3	7.4	7.4	7.6	7.6	7.3	7.3	6.0	6.2	6.7	5.7	5.8	5.4	5.6	20	19	19	21	21	21	21
APG-04/07	7.3	7.3	8.0	7.2	7.2	7.3	7.7	5.1	5.1	7.0	4.2	5.2	4.2	5.3	20	19	19	21	21	21	21
APG-05/09	7.3	7.3	7.8	7.4	7.6	7.4	7.4	5.2	4.9	6.9	4.7	5.4	5.9	4.9	20	19	19	21	21	21	21
APG-10/14	7.3	7.3	7.5	7.3	7.6	7.1	7.2	5.9	5.9	6.5	4.2	4.8	4.5	4.2	20	19	19	21	21	21	21
APG-16/17	7.4	7.4	7.4	7.2	7.4	7.3	7.2	6.0	5.8	6.3	4.0	4.6	4.6	4.2	20	19	19	21	21	21	21
Replicate	A	B	A	B	A	B	A	A	B	A	B	A	B	A	A	B	A	B	A	B	A
Meter	16	16	16	16	16	16	16	5	5	5	5	5	5	5	D41	D41	D41	D41	D41	D41	D41
Date	9/7/11	9/8/11	9/9/11	9/10/11	9/11/11	9/12/11	9/13/11	9/7/11	9/8/11	9/9/11	9/10/11	9/11/11	9/12/11	9/13/11	9/7/11	9/8/11	9/9/11	9/10/11	9/11/11	9/12/11	9/13/11
Time	0845	1120	0940	1450	1345	1015	0900	0845	1120	0940	1450	1345	1015	0900	0845	1120	0940	1450	1345	1015	0900
Initials	AS	TK	TK	KB	NLT	AS	TK	AS	TK	TK	KB	NLT	AS	TK	AS	TK	TK	KB	NLT	AS	TK

Test sediment	pH Test day 7	8	9	10	11	12	13	Dissolved Oxygen (mg/L) Test day 7	8	9	10	11	12	13	Temperature (°C) Test day 7	8	9	10	11	12	13
Form Sed	8.1	8.1	8.2	8.2	8.2	8.0	8.2	6.4	6.5	6.6	6.4	6.4	6.5	6.8	21	20	21	21	21	20	22
APG-02/08	7.6	7.3	7.5	7.5	7.4	7.5	7.5	6.1	5.3	5.8	5.7	5.5	6.2	6.7	21	20	21	21	21	20	21
APG-04/07	7.3	7.7	7.4	7.7	7.4	7.7	7.4	5.0	5.4	4.7	5.5	4.1	5.6	5.5	21	20	20	21	21	20	21
APG-05/09	7.4	7.5	7.4	7.6	7.5	7.6	7.4	5.2	5.3	4.7	5.6	4.4	5.4	5.7	20	20	20	20	21	20	21
APG-10/14	7.2	7.3	7.3	7.4	7.4	7.3	7.4	4.5	4.9	4.3	5.2	3.8*	4.9	5.1	21	20	20	21	21	20	20
APG-16/17	7.3	7.3	7.4	7.4	7.4	7.4	7.5	4.7	4.8	4.4	4.5	4.5	5.3	5.7	21	20	20	21	21	20	20
Replicate	B	A	B	A	B	A	B	B	A	B	A	B	A	B	B	A	B	A	B	A	B
Meter	16	16	16	16	16	16	16	5	5	5	5	5	5	5	D41	D41	D41	D41	D41	D41	D-41
Date	9/14/11	9/15/11	9/16/11	9/17/11	9/18/11	9/19/11	9/20/11	9/14/11	9/15/11	9/16/11	9/17/11	9/18/11	9/19/11	9/20/11	9/14/11	9/15/11	9/16/11	9/17/11	9/18/11	9/19/11	9/20/11
Time	0900	0907	1000	1150	1310	1145	1110	0900	0907	1000	1150	1310	1145	1110	0900	0907	1000	1150	1310	1145	1055
Initials	TK	TK	AM	DM	AS	AB	DM	TK	TK	AM	DM	AS	AB	DM	TK	TK	AM	DM	AS	AB	DM

*C Needham notified

CU 1/9/12
QA- [illegible] 01/26/12

CHEMICAL DATA

Project Number: 60147216-445-(013-020)	Test Species (Circle): *D. magna* *H. azteca* *C. tentans* *E. foetida* **L. variegatus** Other (Specify):

Test sediment	pH							Dissolved Oxygen (mg/L)							Temperature (°C)						
	A Test day							Test day							Test day						
	0	1	2	3	4	5	6	0	1	2	3	4	5	6	0	1	2	3	4	5	6
APG-18/19	7.4	7.8	7.8	7.2	7.4	7.5	7.2	5.8	6.7	6.9	4.2	4.4	4.9	4.3	20	19	19	20	21	21	21
APG-20-21	7.4	7.5	7.6	7.3	7.4	7.4	7.4	5.6	6.2	6.7	4.8	6.0	4.9	6.3	20	19	19	21	21	20	21
APG-22/23	7.1	7.3	7.6	7.3	7.4	7.3	7.2	5.4	5.9	6.2	5.2	5.4	4.9	5.2	20	19	19	21	21	20	21
Replicate	A	B	A	B	A	B	A	A	B	A	B	A	B	A	A	B	A	B	A	B	A
Meter	16	16	16	16	16	16	16	5	5	5	5	5	5	5	D41	D41	D41	D41	D41	D41	D41
Date	9/7/11	9/8/11	9/9/11	9/10/11	9/11/11	9/12/11	9/13/11	9/7/11	9/8/11	9/9/11	9/10/11	9/11/11	9/12/11	9/13/11	9/7/11	9/8/11	9/9/11	9/10/11	9/11/11	9/12/11	9/13/11
Time	0845	1120	0940	1450	1345	1015	0900	0845	1120	0940	1450	1345	1015	0900	0845	1120	0940	1450	1345	1015	0900
Initials	AS	TK	TK	KB	NLT	AS	TK	AS	TK	TK	KB	NLT	AS	TK	AS	TK	TK	KB	NLT	AS	TK

Test sediment	pH							Dissolved Oxygen (mg/L)							Temperature (°C)						
	Test day							Test day							Test day						
	7	8	9	10	11	12	13	7	8	9	10	11	12	13	7	8	9	10	11	12	13
APG-18/19	7.4	7.3	7.4	7.4	7.5	7.3	7.6	5.3	4.9	4.5	4.7	4.5	5.1	5.9	21	20	20	21	21	20	21
APG-20-21	7.5	7.4	7.6	7.5	7.7	7.5	7.8	5.5	4.7	5.4	5.7	4.9	5.4	6.6	21	20	21	21	21	20	21
APG-22/23	7.4	7.4	7.5	7.5	7.5	7.5	7.7	5.5	6.0	5.3	5.5	4.8	5.5	6.4	21	20	20	21	21	20	20
Replicate	B	A	B	A	B	A	B	B	A	B	A	B	A	B	B	A	B	A	B	A	B
Meter	16	16	16	16	16	16	16	① ~~16~~ 5	5	5	5	5	5	5	D41	D41	D41	D41	D41	D41	D41
Date	9/14/11	9/15/11	9/16/11	9/17/11	9/18/11	9/19/11	9/20/11	9/14/11	9/15/11	9/16/11	9/17/11	9/18/11	9/19/11	9/20/11	9/14/11	9/15/11	9/16/11	9/17/11	9/18/11	9/19/11	9/20/11
Time	0900	0907	1000	1150	1310	1145	1110	0900	0907	1000	1150	1310	1145	1110	0900	0907	1000	1150	1310	1145	1055
Initials	TK	TK	AM	DM	AS	AB	DM	TK	TK	AM	DM	AS	AB	DM	TK	TK	AM	DM	AS	AB	DM

① AS for NT 9/12/11 E
② TK 9/15/11 E

CW 1/9/12
QA: GMM 01/26/12

CHEMICAL DATA

Project Number: 60147216-445-(013-020)	Test Species (Circle): D. magna H. azteca C. tentans E. foetida **L. variegatus** Other (Specify):

Test sediment	pH							Dissolved Oxygen (mg/L)							Temperature (°C)						
	Test day							Test day							Test day						
	14	15	16	17	18	19	20	14	15	16	17	18	19	20	14	15	16	17	18	19	20
Form Sed	8.1	8.2	8.2	8.1	8.1	8.2	8.1	6.0	6.8	6.8	6.5	6.0	5.7	6.2	20	21	20	22	22	23	22
APG-02/08	8.1	7.6	7.6	7.4	7.4	7.5	7.4	5.0	6.2	5.9	5.3	5.1	4.7	5.6	20	20	20	21	21	22	21
APG-04/07	7.4	7.4	7.6	7.3	7.5	7.3	7.5	4.6	5.4	5.6	3.7	4.4	3.5	4.9	20	20	20	21	22	21	21
APG-05/09	7.3	7.4	7.6	7.3	7.6	7.5	7.6	4.0	5.9	5.6	4.1	4.6	3.7	4.8	20	20	20	21	21	21	21
APG-10/14	7.3	7.4	7.4	7.2	7.2	7.2	7.2	3.9	5.3	5.1	3.8	3.9	3.2	4.2	20	20	20	21	22	21	21
APG-16/17	7.3	7.5	7.4	7.4	7.2	7.4	7.1	4.5	5.2	5.0	3.8	3.8	3.6	3.7	20	20	20	21	22	21	21
Replicate	A	B	A	B	A	B	A	A	B	A	B	A	B	A	A	B	A	B	A	B	A
Meter	16	16	16	16	16	16	16	5	5	5	5	5	5	5	D41	D41	D41	D41	D41	D41	D41
Date	9/~~28~~21/11	9/22/11	9/23/11	9/24/11	9/25/11	9/26/11	9/27/11	9/21/11	9/22/11	9/23/11	9/24/11	9/25/11	9/26/11	9/27/11	9/~~28~~21/11	9/22/11	9/23/11	9/24/11	9/25/11	9/26/11	9/27/11
Time	0915	1105	0935	0910	0900	1055	0920	0920	1105	0935	0910	0900	1055	0920	0910	1055	0925	0910	0900	1055	0920
Initials	[illegible]	DM	DM	TK	TK	AG	TK	[illegible]	DM	DM	TK	TK	AG	TK	[illegible]	DM	DM	TK	TK	AG	TK

Test sediment	pH							Dissolved Oxygen (mg/L)							Temperature (°C)						
	Test day							Test day							Test day						
	21	22	23	24	25	26	27	21	22	23	24	25	26	27	21	22	23	24	25	26	27
Form Sed	8.2	8.2	8.2	8.1	8.2	8.1	8.2	6.8	6.3	6.7	6.3	6.2	6.4	7.5	23	21	20	23	23	21	21
APG-02/08	7.5	7.5	7.6	7.6	7.6	7.7	7.4	6.3	5.7	6.3	5.3	5.3	5.5	6.9	22	20	20	22	22	21	21
APG-04/07	7.3	7.5	7.4	7.6	7.3	7.7	7.4	5.4	5.2	4.7	4.9	4.1	5.0	6.0	22	20	20	22	22	21	21
APG-05/09	7.5	7.7	7.4	7.7	7.3	8.0	7.6	5.4	5.3	4.9	5.1	4.3	5.4	5.6	22	20	19	22	22	21	21
APG-10/14	7.3	7.4	7.4	7.2	7.2	7.6	7.3	5.1	5.1	4.7	4.6	4.0	5.3	5.4	22	20	19	22	22	21	21
APG-16/17	7.4	7.4	7.4	7.3	7.2	7.5	7.5	4.9	4.5	4.6	5.0	4.6	4.7	5.5	22	20	19	22	22	21	21
Replicate	B	A	B	A	B	A	B	B	A	B	A	B	A	B	B	A	B	A	B	A	B
Meter	16	16	16	16	16	16	16	5	5	5	5	5	5	5	D41	D41	D41	D41	D41	D41	D41
Date	9/28/11	9/29/11	9/30/11	10/1/11	10/2/11	10/3/11	10/4/11	9/28/11	9/29/11	9/30/11	10/1/11	10/2/11	10/3/11	10/4/11	9/28/11	9/29/11	9/30/11	10/1/11	10/2/11	10/3/11	10/4/11
Time	0925	0900	0925	1645	1015	0855	0855	0925	0900	0925	1645	1015	0855	0855	0925	0900	0910	1645	1015	0855	0855
Initials	Am	AB	DM	Am	Am	Am	TK	Am	AB	DM	Am	Am	Am	TK	Am	Am	DM	Am	Am	Am	TK

① AG 9/21/11 E

eu 1/9/12
QA: [illegible] 02/08/12

CHEMICAL DATA

Project Number: 60147216-445-(013-020)	Test Species (Circle): *D. magna* *H. azteca* *C. tentans* *E. foetida* **L. variegatus** Other (Specify):

Test sediment	pH							Dissolved Oxygen (mg/L)							Temperature (°C)						
	Test day							Test day							Test day						
	14	15	16	17	18	19	20	14	15	16	17	18	19	20	14	15	16	17	18	19	20
APG-18/19	7.2	7.7	7.3	7.4	7.2	7.5	7.1	3.9	6.0	5.3	4.5	3.9	4.2	3.9	20	20	20	21	21	22	21
APG-20-21	7.3	7.6	7.4	7.4	7.7	7.7	7.7	4.9	6.2	5.7	4.8	NM	4.2	4.4	20	20	20	21	22	21	① ~~22~~ 21
APG-22/23	7.4	7.6	7.5	7.5	7.4	7.5	7.4	4.9	6.2	5.9	4.7	5.1	4.5	4.6	20	20	20	21	22	22	21
Replicate	A	B	A	B	A	B	B	A	B	A	B	A	B	A	A	B	A	B	A	B	A
Meter	16	16	16	16	16	16	16	5	5	5	5	5	5	5	D41	D41	D41	D41	D41	D41	D41
Date	9/21/11	9/22/11	9/23/11	9/24/11	9/25/11	9/26/11	9/27/11	9/21/11	9/22/11	9/23/11	9/24/11	9/25/11	9/26/11	9/27/11	② 9/21/11	9/22/11	9/23/11	9/24/11	9/25/11	9/26/11	9/27/11
Time	0915	1105	0935	0910	0900	1055	0920	0920	1105	0935	0910	0900	1055	0920	0910	1055	0925	0910	0900	1055	0920
Initials	[illegible]	DM	DM	TK	TK	AG	TK	[illegible]	DM	DM	TK	TK	AG	TK	[illegible]	DM	DM	TK	TK	AG	TK

Test sediment	pH							Dissolved Oxygen (mg/L)							Temperature (°C)						
	Test day							Test day							Test day						
	21	22	23	24	25	26	27	21	22	23	24	25	26	27	21	22	23	24	25	26	27
APG-18/19	7.5	7.3	7.5	7.2	7.4	7.4	7.6	5.4	4.4	5.3	4.5	4.8	4.6	5.7	22	20	19	22	22	21	21
APG-20-21	7.9	7.8	7.7	7.8	7.8	7.8	7.9	6.0	4.7	5.6	5.9	5.2	5.2	6.6	22	21	20	22	22	21	21
APG-22/23	7.6	7.7	7.7	7.5	7.8	7.8	7.7	8.9	5.0	5.7	5.3	5.2	5.4	6.5	22	21	20	22	22	21	21
Replicate	B	A	B	A	B	A	B	B	A	B	A	B	A	B	④ ~~D41~~ B	A	B	A	B	A	B
Meter	16	16	16	16	16	16	16	5	~~16~~ ③ 5	5	5	5	5	5	④ D41	D41	D41	D41	D41	D41	D41
Date	9/28/11	9/29/11	9/30/11	10/1/11	10/2/11	10/3/11	10/4/11	9/28/11	9/29/11	9/30/11	10/1/11	10/2/11	10/3/11	10/4/11	9/28/11	9/29/11	9/30/11	10/1/11	10/2/11	10/3/11	10/4/11
Time	0925	0900	0925	1645	1015	0855	0855	0925	0900	0925	1645	1015	0855	0855	0925	0900	0910	1645	1015	0858	0855
Initials	Am	AB	DM	Am	Am	AB	TK	Am	AB	DM	Am	Am	AB	TK	Am	AB	DM	Am	Am	AB	TK

① TK 9/27/11 E ③ DM for AB 9/30/11 E ④ [illegible] 1/27/12, CF

② Am 9/28/11 E

NM = Not Measured

CW 1/9/12
QA: GKM 02/08/12

CHEMICAL DATA

Project Number: 60147216-445-(013-020)	Test Species (Circle): *D. magna* *H. azteca* *C. tentans* *E. foetida* **L. variegatus** Other (Specify):

Test sediment	pH							Dissolved Oxygen (mg/L)							Temperature (°C)						
	Test day							Test day							Test day						
	28							28							28						
Form Sed	NM▲							NM▲							NM▲						
APG-02/08	7.7							7.0•							21•						
APG-04/07	7.7							7.0							21						
APG-05/09	8.0							7.0							20						
APG-10/14	8.2							6.9							20						
APG-16/17	7.8							6.9							21						
Replicate	A/B							A/B							A/B						
Meter	16							5							~~40~~ D41 ①						
Date	10/5/11							10/5/11							10/6/11						
Time	1100							1100							1100						
Initials	[initials]							[initials]							[initials]						

Test sediment	pH							Dissolved Oxygen (mg/L)							Temperature (°C)						
	Test day							Test day							Test day						
	28							28							28						
APG-18/19	② 7.9 ~~20~~•							6.9•							20•						
APG-20-21	7.9							6.9							21						
APG-22/23	8.1•							6.9•							20•						
Replicate	A/B							A/B							A/B						
Meter	16							5							D41 ~~46~~ ②						
Date	10/5/11							10/5/11							10/5/11						
Time	1100							1100							1100						
Initials	[initials]							[initials]							[initials]						

• Chem Rep taken from B rep 10/5/11 JK ▲NM = Not measured

① JR 10/5/11 WP ② GKM of AMR 02/08/12 CP

cw 1/9/12
QA: 6mm 02/08/12

OVERLYING WATER CHARACTERIZATION

Project Number: 60147216-445-(013-020)	Test Species (Circle): D. magna H. azteca C. tentans E. foetida **L. variegatus** Other (Specify):

Conc.	Hardness (mg/L $CaCO_3$)					Alkalinity (mg/L $CaCO_3$)				
	0	7	14	21	27	0	7	14	21	27
Form Sed	106	72	58	62	68	96	75	60	62	68
APG-02/08	50	86*	38	36	40	43	45	36	35	37
APG-04/07	56	64	52	54	62	58	80	54	46	55
APG-05/09	56	64	56	66	86	61	80	59	71	97
APG-10/14	30	38	34	30	32	35	48	42	33	28
APG-16/17	52	44	46	40	54	52	54	54	39	47
APG-18/19	56	46	46	44	50	55	56	53	39	40
APG-20/21	50	60	52	82	88	50	78	54	98	105
APG-22/23	44	42	36	36	40	45	55	40	39	41
Meter#	Titr	Titr	Titr	Titr	Titr	Titr	Titr	Titr	Titr	Titr
Date:	9/7/11	9/14/11	9/21/11	9/28/11	10/4/11	9/7/11	9/14/11	9/21/11	9/28/11	10/4/11
Time:	1310	0930	1115	1000	1530	1310	0930	1115	1000	1530
Initials:	NLT	cw for AMR	KB	cw for AMR	AP	NLT	cw for AMR	KB	cw for AMR	AP

Conc.	Conductivity (µS/cm)					NH_3 (mg/L)				
	0	7	14	21	27	0	7	14	21	27
Form Sed	192	178	144	145	① ~~146~~ 160	<1.0	<1.0	<1.0	<1.0	<1.0
APG-02/08	132	132	110	110	127	<1.0	1.4	<1.0	<1.0	<1.0
APG-04/07	169	234	166	162	206	<1.0	2.6	① ~~<~~1.2	<1.0	<1.0
APG-05/09	169	221	165	185	259	<1.0	1.4	<1.0	<1.0	<1.0
APG-10/14	② ~~127~~ 123	181	165	171	157	<1.0	2.6	2.7	2.2	2.0
APG-16/17	176	185	180	143	193	<1.0	1.8	2.2	① ~~2~~ <1.0	<1.0
APG-18/19	193	191	188	146	175	<1.0	1.8	1.8	<1.0	<1.0
APG-20/21	161	259	171	279	288	<1.0	1.8	<1.0	<1.0	<1.0
APG-22/23	148	180	139	151	177	<1.0	2.0	<1.0	<1.0	<1.0
Meter#	15	15	15	15	15	HA#1	HA#1	HA#1	HA#1	HA#1
Date:	9/7/11	9/14/11	9/21/11	9/28/11	10/4/11	9/7/11	9/14/11	9/21/11	9/28/11	10/4/11
Time:	1310	0930	1115	1000	1530	1310	0930	1115	1000	1530
Initials:	NLT	cw for AMR	KB	cw for AMR	AP	NLT	cw for AMR	KB	cw for AMR	AP

* Note: This value is suspect and will not be reported.

① AB 12/8/11 C
② cw for AB 01/27/12 CF

DAILY TOXICITY TEST LOG

Project Number: 60147216-445-(013-020)	Test Species (Circle): D. magna H. azteca C. tentans E. foetida **L. variegatus** Other (Specify):

Test Day	Comments Temps (°C)	Feeding (None)	Date & Initials
-1	Chambers filled with sediments and overlying water placed in test bath @ 0950-1335 Water drip started @1420 approx. drip rate = 2.8 mL/min	None	AS/CW 09/06/11
0	Test Organisms added @ 1030-1120 CT = 20.4°C Range 20.0°C to 20.8°C	None	AS/NET 9/7/11
1	CT = 19.8 Range 19.4 to 20.4	None	R 9/8/11
2	CT = 20.2 Range 19.4 to 20.8	None	R 9/9/11
3	CT = 20.2 Range 19.6 to 20.8	None	VB 9/10/11 ①
4	CT = 20.2 Range 19.6 to 20.8	None	R 9/11/11
5	CT = 20.4°C Range 19.6°C to 20.8°C	None	AS 9/12/11
6	CT = 21.8°C Range 20.4 to 22.8°C	None	CW 9/13/11
7	CT = 23.2 Range 22.6 to 23.6	None	R 9/14/11
8	CT = 22.4 Range 21.4 to 22.8	None	R 9/15/11
9	CT = 21.8 Range 21.2 to 22.2	None	AM 9/16/11
10	CT = 22.4 Range 21.2 to 22.8	None	DM 9/17/11
11	CT = 22.4°C Range 21.2°C to 22.8°C	None	AS 9/18/11
12	CT = 20.8 Range ~~20.8~~ ③ 20.0 to 21.2	None	AB 9/19/11
13	CT = 22.0 Range 20.0 to 22.8	None	DM 9/20/11
14	CT = ~~22.0~~ ③ 22.2 Range 21.4 to 22.6	None	AD 9/21/11

① VB 9/10/11 E ② CW for AB 12/12/11 E
③ CW for ANP 12/12/11 E

cw 1/19/12
QA: bum 02/08/12

DAILY TOXICITY TEST LOG

Project Number: 60147216-445-(013-020)	Test Species (Circle): *D. magna* *H. azteca* *C. tentans* *E. foetida* **L. variegatus** Other (Specify):

Test Day	Comments Temps (°C)	Feeding (None)	Date & Initials
15	CT = 21.8 °C Range 21.2 to 22.6 °C	None	① ~~cw~~ DM 9/22/11 ~~09/06/11~~ ①
16	CT = 22.2 Range 21.2 to 22.8 °C	None	DM 9/23/11
17	CT = 23.2 Range 22.2 to 23.6	None	R 9/24/11
18	CT = 23.6 Range 22.8 to 24.0	None	R 9/25/11
19	CT = 23.6 Range 23.2 to 24.0	None	9/26/11 AB
20	CT = 23.6 Range 23.2 to 23.6	None	R 9/27/11
21	CT = 23.4 Range 23.2 to 23.6	None	Am 9/28/11
22	CT = 23.4 Range 23.2 to 24.0	None	AB 9/29/11
23	CT = 23.2 Range 22.6 to 23.6	None	DM 9/30/11
24	CT = 23.8 Range 22.6 to 24.6	None	Am 10/1/11
25	CT = ~~23.8~~ ② 24.2 Range ~~23.4~~ ② 24.0 to ~~24.2~~ ② 24.6	None	Am 10/2/11
26	CT = 24.2 Range 24.0 to 24.6	None	AB 10/3/11
27	CT = 24.4 Range 24.0 to 24.6 Composites of waters collected for characterization @ 10/4/11 @ 0750 cw	None	cw 10/4/11
28	Adults collected from sediment chambers and transferred to clean water @ ~~10/5-10/10~~ Organisms weighed (unblotted wet weight), transferred to clean sample bottles, and placed in freezer @ 10/5-10/7 @ 0800-1730 ~~@ 0800-1730~~ @ ~~8/4-8/6~~ ③ ~~10/4-10/6/11 @ 1530-1830~~ ④ 10/4/11 @ 0815-1900 10/5/11 @ 0745-1835 10/6/11 @ 0745-1830 CT = 24.0 Range 23.6 to 24.2	None	cw 10/5/11

① cw 09/06/11 wp ② cw for AMR 12/12/11 E ③ cw 12/12/11 wp ④ cw 01/27/12 cf

Sample	Replicate	Date	Start Time	End Time	Initials
Formulated	A	10/4/11	1000	① ~~3~~ 1535	DM
(control)	B	10/5/11	0800/1330	1020/1630	AB
APG-02/08	A	10/4/11	0820/1545	1830/1900	CW/AR
	B	10/6/11	0750	1830	AB
APG-22/23	A	10/4/11	① ~~1000~~ 0900	1830	① DM/KB
	B	10/6/11	0845	1830	DB/RGN
APG-05/09	A	10/5/11	0745/1545	1810/1820	TF/AP
	B	10/5/11	0815/1530/1300	1200/1835/1835	[illegible]/KB/CW
APG-04/07	A	10/6/11	0745/1540	1800/1830	TF/AR
	B	10/4/11	0815	1820	AB
APG-18/19	A	10/4/11	0815/1545 AR	1730	NLT/AR
	B	10/6/11	0810	1830	[illegible]
APG-16/17	A	10/5/11	0745	1630	AB
	B	10/6/11	0815/1100	1830/1830	[illegible]/KB
APG-10/14	A	10/5/11	0830	1800	Am
	B	10/4/11	② 0820	1800	CD/TR
APG-20/21	A	10/5/11	0800/1505	1830	CD/AR
	B	10/6/11	1030/1046/1630	1830	NLT/W/AR/CW

① DM 10/4/11
② GM for ?. 01/20/12 CF/NA
APG 20/21 B - worms lethargic, not much movement (AR)

APPENDIX C

Test Round 2 Laboratory Data Sheets

cw 1/9/12
QA: GLM 01/26/12

TOXICITY DATA PACKAGE COVER SHEET

Test Type: Chronic

Test Substance: Sediment

Overlying Water Type: Filtered Horsetooth water

Concurrent Control Sediment Type: Formulated Sediment

Date and Time Test Began: 9/13/11 @ 1000-1030

Protocol Number: USEPA (2000) + ASTM (2009)

Project Number: 60147216-445-(021-025)

Species: *Lumbriculus variegatus*

Organism Lot or Batch Number: 11-018

Age: adult (adult) Supplier: Bayou Aquatics

Date and Time Test Ended: ~~10/10 10/11/11 @ 0730 - 1700 (see day 0)~~ 10/10/11 @ 0800-1745, 10/11/11 @ 0800-1720

Investigator(s): AB/cw/KF/Am/DM/AB/KB/AP/NLT/BP JM/HKT/AP/?/cw for RDN/AB

Background Information

Type of Test: Continuous Drip Renewal

Test Temperature: 23 ± 1 °C

pH Control?: Yes No If Yes, give % CO_2: N/A

Env. Chmbr/Bath #: ~~4~~ 3 Test Chambers: 2.5 gal glass aquaria

Test Sediment Vol.: 1000 ml Overlying Water Volume: ~2 L Number of Replicates per Treatment: 2

Length of Test: 28 days Number of Organisms per Replicate: to maintain > 5:1 sediment organic carbon:org. dry weight

Type of Food and Quantity per Chamber: None Feeding Frequency: NA

Photoperiod: 16h Light : 8h Dark Light Intensity: 9.3-93 ft-c.

Overlying Water Characterization Parameters and Frequency: Hardness: Day 0,7,14,21,27 Alkalinity: Day 0,7,14,21,27

NH_3: Day 0,7,14,21,27 pH: Day 0,7,14,21,27 Conductivity: Day 0,7,14, 21,27 TRC: NA

Test Concentrations: Formulated Sediment, APG-01/03, APG-06/24, APG-11/13, and APG-12/15

Reference Toxicant Data: Test Dates: NA to —		LC50 or IC25 (Circle): —
Hist. 95% Control Limits: NA to —		Method for Determining Ref. Tox. Value: —

Special Procedures and Considerations:
Sediments will be homogenized before use in testing.
Hard/alk, pH, cond, and NH_3 of the overlying water will be measured on days 0, 7, 14, 21, and 27
DO will be measured daily and is to be maintained at ≥2.5 mg/L
Overlying water renewal rate at approximately 2 volume additions (4000 ml) per day, or ~~2.3~~ ~2.8 ml/min
Study Director Initials: RBN Date: 9/12/11

@cw 09/10/11 a @cw 12/12/11 E @cw 01/27/12 cf

CW 1/9/12
QA: GLM 01/26/12

SEDIMENT/SOIL PREPARATION

Artificial soil	
Constituent/source	**Amount added (g)**
Rinsed Medium Grit Silica Sand	8500
Clay/Silt Mixture (ASP 400)	1500
Dolomite	5
Humic Acid (Sodium Salt) (Lot #C10-034)	1
Sieved Sphagnum Moss	220
Calcium Carbonate (Lot #C02-064)	115 ~~1050~~

Notes: Medium grit silica sand was rinsed with deionized water and baked overnight in 105°C oven prior to sediment mixing.

Sphagnum Moss was sieved using a 2 mm sieve prior to mixing. Calcium carbonate added to raise soil pH from 3.4 to final pH of 6.7.

See page 3 of Round 1 data sheets for preparation of formulated sediment notes. CW (#60225262-445-[013-020])

Soil/sediment	FCETL#	Homogenization			
		Date	From	To	Analyst
Form. Sed	N/A	09/12/11	1015	1018	CW
APG-01/03 A	24843	09/12/11	1010	1040	AB
APG-01/03 B	24843	09/12/11	1045	1105	AB
APG-06/24 A	24848	09/12/11	1045	1049	CW
APG-06/24 B	24848	09/12/11	1103	1107	CW
APG-11/13 A	24850	09/12/11	1132	1136	CW
APG-11/13 B	24850	09/12/11	1148	1152	CW
APG-12/15 A	24846	09/12/11	1115	1120	AB
APG-12/15 B	24846	09/12/11	1135	1150	AB

Note: Replicates homogenized and tested separately per client's request.

CW 01/27/12

CW 1/9/12
QA: GMM 02/08/12

BIOLOGICAL DATA

Project Number: 60147216-445-(021-025)	Test Species (Circle): *H. azteca* *C. tentans* *E. foetida* **L. variegatus** Other (Specify):

Treatment / Sediment	Rep.	Initial: Wet Weight Unblotted worms (g)[a]	Initial: Calculated Wet Weight Blotted Worms[b]	Initial: Calculated Dry Weight Worms[c]	Initial: Sediment Organic:Dry Worm Weight Ratio[d]	Final: Wet Weight Unblotted Worms (g)[a,e]
Form. Sed (control)	A	2.7				1.7
	B	2.7				1.6
	C	—				~~1.7~~ ① —
APG-01/03	A	9.0				6.4
	B	9.0				4.5
	C	—				—
APG-06/24	A	9.0		②		3.9
	B	9.0				3.5
	C	—				—
APG-11/13	A	9.0				3.6
	B	9.0				3.3
	C	—				—
APG-12/15	A	9.0				6.1
	B	9.0				5.1
	C	—				—
	A					
	B					
	C					
Date		9/13/11				10/11/11 and 10/12/11
Time		1000-1030				0800-1700
Analyst		CW/AB				CW/AB

[a] Measured Using Balance Number AND Top Loader
[b] Unblotted wet weight of worms divided by 1.33
[c] Ratio applied to unblotted wet weight of worms : 0.117
[d] Sediment organic content calculated NA
[e] Organisms depurated from 10/10 + 10/11/11 @ ~1700 to 10/11 + 10/12/11 @ ~0800 (date/time) in
homeroom water / 500 ml beakers (water/holding vessel)

① AB 10/13/11 WP

② GMM 02/09/12 NA, see page 4

BIOLOGICAL DATA

cw 12/12/11
QA: GWM 01/26/12

Project Number: 60147216-445-(021-025)

Test Species: *Lumbriculus variegatus*

		Initial			Final	
Sample Name	**Rep**	**Wet Weight of Unblotted Worms (g)**	**Est. Blot Dry Wt. of Worms Added (g)[a]**	**Est. Dry Wt. of Worms Added (g)[a]**	**Wet Weight of Unblotted Worms (g)**	**% Recovery**
Form Sed (control)	A	2.7	2.03	0.24	1.7	63%
	B	2.7	2.03	0.24	1.6	59%
APG-01/03	A	9.0	6.77	0.79	6.4	71%
	B	9.0	6.77	0.79	4.5	50%
APG-06/24	A	9.0	6.77	0.79	3.9	43%
	B	9.0	6.77	0.79	3.5	39%
APG-11/13	A	9.0	6.77	0.79	3.6	40%
	B	9.0	6.77	0.79	3.3	37%
APG-12/15	A	9.0	6.77	0.79	6.1	68%
	B	9.0	6.77	0.79	5.1	57%

[a] Calculated by dividing unblotted wet weight by 1.33 (USEPA, 2000) to obtain blotted wet weight and then multiplying estimated blotted wet weight by 0.117 (wet weight to dry weight conversion calculated by FCETL during previous studies)

Note: Values are rounded to two digits; some slight differences may be found when applying conversion factors to rounded values

CW 1/19/12
QA: GKM 01/20/12

CHEMICAL DATA

Project Number: 60147216-445-(021-025)	Test Species (Circle): *D. magna* *H. azteca* *C. tentans* *E. foetida* $\boxed{\textit{L. variegatus}}$ Other (Specify):

Test sediment	pH							Dissolved Oxygen (mg/L)							Temperature (°C)						
	Test day							Test day							Test day						
	0	1	2	3	4	5	6	0	1	2	3	4	5	6	0	1	2	3	4	5	6
Form Sed	8.3	8.2	8.1	8.1	8.1	8.1	8.0	~~4.6~~ 6.7①	6.2	6.5	6.2	~~4.9~~ 6.43②	6.0	6.2	23	22	22	22	21	21	21
APG-01/03	7.6	7.2	7.3	7.4	7.4	7.3	7.2	6.3	4.9	4.9	4.9	4.9	3.8*	4.7	23	22	22	22	21	22	20
APG-06/24	7.3	7.1	7.2	7.4	7.4	7.4	7.4	5.8	4.8	4.9	5.1	4.9	4.6	5.5	22	22	21	22	22	22	20
APG-11/13	7.6	7.2	7.4	7.5	7.4	7.5	7.5	6.2	4.9	4.9	5.4	5.3	4.7	5.7	23	22	22	22	22	22	20
APG-12/15	7.6	7.2	7.3	7.4	7.4	7.3	7.4	6.3	4.7	4.7	4.8	4.9	4.0	4.5	22	22	22	21	22	21	20
Replicate	A	B	A	B	A	B	A	A	B	A	B	A	B	A	A	B	A	B	A	B	A
Meter	16	16	16	16	16	16	16	5	5	5	5	5	5	5	D41	D41	D41	D41	D41	D41	D41
Date	9/13/11	9/14/11	9/15/11	9/16/11	9/17/11	9/18/11	9/19/11	9/13/11	9/14/11	9/15/11	9/16/11	9/17/11	9/18/11	9/19/11	9/13/11	9/14/11	9/15/11	9/16/11	9/17/11	9/18/11	9/19/11
Time	1000	0900	0907	1015	1150	1310	1145	1000	0900	0907	1015	1150	1310	1145	1000	0900	0907	1005	1150	1310	1145
Initials	CW	TK	TK	AM	DM	AS	AB	CW	TK	TK	AM	DM	AS	AB	CW	TK	TK	AM	DM	AS	AB

Test sediment	pH							Dissolved Oxygen (mg/L)							Temperature (°C)						
	Test day							Test day							Test day						
	7	8	9	10	11	12	13	7	8	9	10	11	12	13	7	8	9	10	11	12	13
Form Sed③	~~22~~ 8.4	7.3	8.1	8.1	8.0	8.0	8.1	6.7	4.9	6.9	6.6	6.5	6.1	5.4	22	21	22	22	23	23	23
APG-01/03③	~~22~~ 7.5	7.3	7.4	7.5	7.3	7.4	7.4	6.0	4.5	5.7	5.5	4.3	4.0	3.4	22	21	22	22	23	23	23
APG-06/24③	~~22~~ 7.5	7.4	7.5	7.5	7.3	7.4	7.4	6.2	4.5	5.8	5.6	5.0	4.5	4.3	22	21	22	22	22	23	23
APG-11/13③	~~22~~ 7.5	7.4	7.6	7.5	7.4	7.4	7.4	6.1	4.7	6.0	5.8	5.2	4.5	4.4	22	21	22	22	22	23	23
APG-12/15③	~~22~~ 7.4	7.4	7.5	7.5	7.3	7.4	7.4	5.7	3.7	5.6	5.5	4.4	4.0	3.3	22	21	22	22	22	23	22
															~~22~~③	~~21~~④					
Replicate	B	A	B	A	B	A	B	B	A	B	A	B	A	B	~~B~~③ B	A	B	A	B	A	B
Meter ③	~~D41~~ 16	16	16	16	16	16	16	5	5	5	5	5	5	5	D41	D41	D41	D41	D41	D41	D41
Date	9/20/11	9/21/11	9/22/11	9/23/11	9/24/11	9/25/11	9/26/11	9/20/11	9/21/11	9/22/11	9/23/11	9/24/11	9/25/11	9/26/11	9/20/11	9/21/11	9/22/11	9/23/11	9/24/11	9/25/11	9/26/11
Time ③	~~1055~~ 1110	0910	1105	0935	0910	0900	1055	1110	0915	1109	0935	0910	0900	1055	1055	0905	1055	0925	0910	0900	1055
Initials	DM	AS	DM	DM	TK	TK	AS	DM	AS	DM	DM	TK	TK	AS	DM	AS	DM	DM	TK	TK	AS

① CW 09/13/11 E ② DM 9/17/11 E ③ DM 9/20/11 WP ④ AS 9/22/11 E

* C. Needham notified

cw 11/9/12
QA: GKM 02/08/12

CHEMICAL DATA

Project Number: 60147216-445-(021-025)	Test Species (Circle): D. magna H. azteca C. tentans E. foetida **L. variegatus** Other (Specify):

Test sediment	pH							Dissolved Oxygen (mg/L)							Temperature (°C)						
	Test day							Test day							Test day						
	14	15	16	17	18	19	20	14	15	16	17	18	19	20	14	15	16	17	18	19	20
Form Sed	8.0	8.1	8.1	8.1	~~7~~ 8.1	8.1	8.2	6.0	6.1	6.1	6.1	5.9	6.0	6.2	23	24	23	21	24	24	22
APG-01/03	7.3	7.4	7.4	7.5	7.2	7.4	7.6	4.0	4.8	4.4	5.2	4.1	4.2	4.8	23	24	23	21	23	23	22
APG-06/24	7.2	7.3	7.5	7.5	7.5	7.4	7.6	4.3	5.1	5.1	5.3	5.0	4.5	5.1	23	23	22	21	23	23	22
APG-11/13	7.4	7.5	7.6	7.6	7.5	7.5	7.7	4.6	5.2	5.2	5.7	5.2	5.4	5.7	23	24	23	21	23	23	22
APG-12/15	7.3	7.5	7.5	7.6	7.3	7.4	7.5	3.8	4.7	4.4	5.1	4.0	4.1	4.6	23	23	23	20	23	23	22
Replicate	A	B	A	B	A	B	A	A	B	A	B	A	B	A	A	B	A	B	A	B	A
Meter	16	16	16	16	16	16	16	5	5	5	5	5	5	5	D41	D41	D41	D41	D41	D41	D41
Date	9/27/11	9/28/11	9/29/11	9/30/11	10/1/11	10/2/11	10/3/11	9/27/11	9/28/11	9/29/11	9/30/11	10/1/11	10/2/11	10/3/11	9/27/11	9/28/11	9/29/11	9/30/11	10/1/11	10/2/11	10/3/11
Time	0920	0930	0900	0925	1640	1020	0855	0920	0930	0900	0925	1640	1020	0855	0920	0930	0900	0910	1640	1020	0855
Initials	TK	AM	AB	DM	AM	AM	AB	TK	AM	AB	DM	AM	AM	AB	TK	AM	AB	DM	AM	AM	AB

Test sediment	pH							Dissolved Oxygen (mg/L)							Temperature (°C)						
	Test day							Test day							Test day						
	21	22	23	24	25	26	27	21	22	23	24	25	26	27	21	22	23	24	25	26	27
Form Sed	⑤ ~~22~~ 8.2	9.1	8.2	8.1	8.2	8.3	8.3	7.3	6.9	6.7	6.6	6.6	6.6	7.0	22	23	22	22	21	20	① ~~22~~ 19
APG-01/03	~~22~~ 7.5	7.6	7.6	7.6	7.6	7.3	7.6	6.3	6.5	5.8	5.1	4.4	4.8	7.1	22	22	21	22	20	19	① ~~20~~ 18
APG-06/24	~~22~~ 7.6	7.7	7.6	7.5	7.6	7.6	7.7	6.8	6.6	5.7	5.6	4.8	5.0	7.2	22	22	21	21	20	19	① ~~19~~ 18
APG-11/13	~~22~~ 7.8	7.9	7.8	7.7	7.8	7.6	7.9	6.7	6.9	③ ~~6.9~~ 5.9	5.7	5.1	5.5	6.9	22	22	21	22	20	20	① ~~20~~ 18
APG-12/15	~~22~~ 7.6	7.8	7.5	7.6	7.6	7.4	7.6	5.9	6.4	4.9	4.7	4.3	4.8	6.5	22	22	21	21	21	20	① ~~20~~ 18
Replicate	B	A	B	A	B	A	B	B	A	B	A	B	A	B	B	A	B	A	B	A	④ ~~A~~ B
Meter	16	16	16	FM20	FM20	FM20	FM20	5	5	5	5	5	5	5	D41	D41	D41	D41	D41	D41	D41
Date	10/4/11	10/5/11	10/6/11	10/7/11	10/8/11	10/9/11	10/10/11	10/4/11	10/5/11	10/6/11	10/7/11	10/8/11	10/9/11	10/10/11	10/4/11	10/5/11	10/6/11	10/7/11	10/8/11	10/9/11	④ ~~10/9~~ 10/11
Time	0855	1050	1135	0930	1600	1505	1025	0855	1055	1135	0930	1600	1505	1025	0855	0800	1135	0930	1600	1505	0745
Initials	TK	[illegible]	DM	KB	KB	NLT	TK	TK	[illegible]	DM	KB	KB	NLT	TK	TK	[illegible]	DM	KB	KB	NLT	AB

① AM 10/11/11 WP ③ DM 10/6/11 CI
② TK 10/4/11 TK WP ④ NLT 10/9/11 E
⑤ AB 10/10/11 E

CW 1/9/12
QA: GKM 01/26/12

CHEMICAL DATA

Project Number: 60147216-445-(021-025)	Test Species (Circle): *D. magna* *H. azteca* *C. tentans* *E. foetida* **L. variegatus** Other (Specify):

Test sediment	pH							Dissolved Oxygen (mg/L)							Temperature (°C)						
	Test day							Test day							Test day						
	28							28							28						
Form Sed	8.4							7.3							20						
APG-01/03	7.9							7.4							20						
APG-06/24	8.0							7.4							20						
APG-11/13	8.3							7.4							20						
APG-12/15	8.0							7.3							20						
Replicate	A							A							A						
Meter	FM20							5							D41						
Date	10/11/11							10/11/11							10/11/11						
Time	1715							1715							0800						
Initials	AB							AB							AB						

ω 1/9/12
QA: fum 01/26/12

OVERLYING WATER CHARACTERIZATION

Project Number: 60147216-445-(021-025)	Test Species (Circle): D. magna H. azteca C. tentans E. foetida **L. variegatus** Other (Specify):

Conc.	Hardness (mg/L $CaCO_3$)					Alkalinity (mg/L $CaCO_3$)					Conductivity (µS/cm)					NH_3 (mg/L)				
	0	7	14	21	27	0	7	14	21	27	0	7	14	21	27	0	7	14	21	27
Form Sed	60	60	64	90	130	57	108	65	90	127	134	145	153	207	294	<1.0	<1.0	<1.0	<1.0	<1.0
APG-01/03	36	32	50	42	44	38	36	57	38	35	109	101	162	145	156	<1.0	1.3	2.8	<1.0	<1.0
APG-06/24	38	36	38	40	46	41	40	35	41	49	133	121	111	128	148	1.1	<1.0	<1.0	<1.0	<1.0
APG-11/13	36	40	52	74	88	37	44	52	79	94	112	130	174	258	329	<1.0	<1.0	<1.0	<1.0	<1.0
APG-12/15	38	42	46	52	62	37	47	55	51	49	118	149	169	198	247	<1.0	1.8	73.0 (*)	3.4 ▲	1.5
Meter#	Titr	Titr	Titr	Titr	Titr	Titr	Titr	Titr	Titr	Titr	15	15	15	15	15	HA#1	HA#1	HA#1	HA#1	HA#1
Date:	9/13/11	9/20/11	9/27/11	10/4/11	10/10/11	9/13/11	9/20/11	9/27/11	10/4/11	10/10/11	9/13/11	9/20/11	9/27/11	10/4/11	10/10/11	9/13/11	9/20/11	9/27/11	10/4/11	10/10/11
Time:	1040	1620	1515	1055	1035	1040	1620	1515	1055	1035	1040	1620	1515	1055	1035	UNK	1600	1630	UNK	1730
Initials:	TK	(1) AP	AP	TK	TK	TK	CU for DM	AP	TK	TK	TK	CU for DM	AP	TK	TK	TK/AB	NLJ	~~AP~~ BR	UJT	BR

(1) AP 1/10/11 WP

(*) Sample not preserved due to technician error.
▲ measured 10/12/11 on a preserved sample (meter #3).

DAILY TOXICITY TEST LOG

Project Number: 60147216-445-(021-025)	Test Species (Circle): *D. magna* *H. azteca* *C. tentans* *E. foetida* **L. variegatus** Other (Specify):

Test Day	Comments (Temps. °C)	Feeding (None)	Date & Initials
-1	Chambers filled with sediments and overlying water placed in test bath @0920-1200 Water drip started @1330 approx. drip rate = ~~2.3~~ 2.8② mL/min	None	cw / AB 9/12/11
0	Test Organisms added @1000-1030 CT = 21.6°C Range 19.8 to 22.6°C	None	cw 9/13/11
1	CT = 23.4 Range 22.6 to 23.8	None	F 9/14/11
2	CT = 23.2 Range 22.~~0~~4① to 23.4	None	R 9/15/11
3	CT = 22.2 Range 21.6 to 22.6	None	AN 9/16/11
4	CT = 22.6 Range 21.6 to 23.0	None	DM 9/17/11
5	CT = 22.8°C Range 22.0 to 23.0°C	None	AS 9/18/11
6	CT = 21.2 Range 20.6 to 22.0	None	AB 9/19/11
7	CT = 22.2 Range 20.6 to 23.0	None	DM 9/20/11
8	CT = 22.8 Range 22.4 to 23.0	None	AS 9/21/11
9	CT = 22.8 Range 22.4 to 23.0	None	DM 9/22/11
10	CT = 22.8 Range 22.4 to 23.4	None	DM 9/23/11
11	CT = 23.4 Range 22.6 to 23.8	None	R 9/24/11
12	CT = 24.0 Range 23.8 to 24.4	None	TC 9/25/11
13	CT = 24.2 Range 24.2 to 24.4	None	AS 9/26/11
14	CT = 24.2 Range 24.2 to 24.4	None	R 9/27/11

① cw for TK 12/12/11
② cw 01/27/12 cf

DAILY TOXICITY TEST LOG

Project Number: 60147216-445-(021-025)	Test Species (Circle): *D. magna* *H. azteca* *C. tentans* *E. foetida* **L. variegatus** Other (Specify):

Test Day	Comments Temps (°C)	Feeding (None)	Date & Initials
15	CT = 24.2 Range 24.2 to 24.4	None	9/28/11 AMR
16	CT = 24.2 Range 24.2 to 24.4	None	AB 9/29/11
17	CT = 23.8 Range 22.6 to 24.2	None	DM 9/30/11
18	CT = ~~23.8~~ ④ 24 Range 22.6 to ~~24.2~~ ④ 23.8	None	AN 10/1/11
19	CT = 23.8 Range ~~22.8~~ ④ 23.4 to 24.2	None	AN 10/2/11
20	CT = ~~23.2~~ ① 24.2 Range ~~23.8~~ ① 23.8 to 24.4	None	AB 10/3/11
21	CT = 24.2 Range 24.2 to 24.4	None	K 10/4/11
22	CT = 24.2 Range 24.2 to 24.4	None	AB 10/5/11
23	CT = 24.0 Range 23.4 to 24.4	None	DM 10/6/11
24	CT = 23.0 Range 21.6 to 23.8	None	KB 10/7/11
25	CT = 22.0 Range 21.6 to ~~23.6~~ ③ 22.4	None	KB 10/8/11
26	CT = 21.0 Range ~~19.0~~ ③ 21.0 to ~~22.0~~ ③ 21.2	None	KB 10/9/11
27	CT = ~~20.2~~ ① 20.4 Range 19.8 to 20.6 Composites of waters collected for characterization @ 0730	None	K 10/10/11
28	Adults collected from sediment chambers and transferred to clean water @ 10/10-10/11 @ 1400-1800 Organisms weighed (unblotted wet weight), transferred to clean sample bottles, and placed in freezer @ 10/11-10/12 @ 0800-1730 CT = 21.0 Range 19.8 to 21.2°C	None	cw 10/11/11

① AB 10/3/11 E ① ② cw for AMR 12/12/11 E ③ cw for KB 12/12/11 E ④ cw for AND 12/12/11 E

Lumbriculus variegatus Bioaccumulation
Test Termination

cw 1/9/12
QA: GVM 02/08/12

Sample	Replicate	Date	Start Time	End Time	Initials	Notes
Formulated	A	10/11/11	0815	1515	JM AS	Some worms on top of soil
	B	10/10/11	0810	1500	AS/mt	Worms not visible
APG-01/03	A	10/11/11	0815/0925 AR/1530	1710/1700/1700	AS, RM, AS NC/AR	worms evenly distributed
	B	10/10/11	0815/0910 AR	1700/1715	AS/AR	No worms visible
APG-06/24	A	10/11/11	0800/0800	1600/1600	TK/AB	No worms visible
	B	10/10/11	0816	1725	AS/JM	No worms visible
APG-11/13	A	10/~~10~~ 11/11	0800	1720	RM NC	No worms visible
	B	10/10/11	0825/1550	1720/1700	R/cw/AR	No worms visible Plants growing
APG-12/15	A	10/11/11	0815	1700	cw/mt	worms evenly distributed
	B	10/10/11	0800/1700 AR	1745	AR/AB/RN	Worms evenly distributed

① cw for NCT 10/11/11 E

APPENDIX D

Chain of Custody Records for Tissue Samples sent to Analytical Laboratory

AECOM

CHAIN OF CUSTODY RECORD

Client/Project Name: 445	Project Location: FCETL/AECOM
Project Number: 60147216-445-(013-020)	Field Logbook No.:
Sampler (Print Name)/(Affiliation): Christina Needham/AECOM	Chain of Custody Tape Nos.: 42631
Signature: Christina Needham	Send Results/Report to: Rami Naddy — TAT: Std

Analysis Requested: PCB Analysis

Container Type: P – Plastic; A – Amber Glass; G – Clear Glass; V – VOA Vial; O – Other; E – Encore

Preservation: 1 – HCl, 4°; 2 – H2SO4, 4°; 3 – HNO3, 4°; 4 – NaOH, 4°; 5 – NaOH/ZnAc, 4°; 6 – Na2S2O3, 4°; 7 – 4°

Matrix Codes: DW – Drinking Water; WW – Wastewater; GW – Groundwater; SW – Surface Water; ST – Storm Water; W – Water; S – Soil; SL – Sludge; SD – Sediment; SO – Solid; A – Air; L – Liquid; P – Product

Field Sample No./Identification	Date	Time	COMP	GRAB	Sample Container (Size/Mat'l)	Matrix	Preserv.	Field Filtered	PCB Analysis	Lab I.D.	Remarks
Form Sed A	10/5/11	1030			20mL Vial	Tissue	Ice		X		
Form Sed B	10/5/11	1940									
APG-02/08A	10/5/11	1630									
APG-02/08B	10/7/11	1325									
APG-04/07A	10/7/11	1210									
APG-04/07B	10/5/11	1445									
APG-05/09A	10/6/11	1630									
APG-05/09B	10/6/11	1605									
APG-10/14A	10/6/11	1415									
APG-10/14B	10/5/11	1940									
APG-16/17A	10/6/11	1540									
APG-16/17B	10/7/11	1235									
Lot # 11-018	9/13/11	1100									

Relinquished by: (Print Name)/(Affiliation)	Date / Time	Received by: (Print Name)/(Affiliation)	Date / Time
Christina Needham/AECOM Signature: Christina Needham	Date: 10/10/11 Time:	Signature:	Date: Time:
Signature:	Date: Time:	Signature:	Date: Time:
Signature:	Date: Time:	Signature:	Date: Time:

Analytical Laboratory (Destination):
~~AECOM Toxicology Lab 4303 W. Laporte Avenue Fort Collins, CO 80521 (970) 416-0916 (970) 490-2963 (FAX)~~
University of New Hampshire

Sample Shipped Via: UPS FedEx Courier Other

Temp blank: Yes No

Serial No. № 51658

AECOM

CHAIN OF CUSTODY RECORD

Client/Project Name: 445	Project Location: FCETL / AECOM		
Project Number: 60147216-445-(013-020)	Field Logbook No.:		
Sampler (Print Name)/(Affiliation): Christina Needham / AECOM	Chain of Custody Tape Nos.: 42631		
Signature: Christina Needham	Send Results/Report to: Rami Naddy	TAT: Std	

Container Type: P – Plastic; A – Amber Glass; G – Clear Glass; V – VOA Vial; O – Other; E – Encore

Preservation: 1 – HCl, 4°; 2 – H2SO4, 4°; 3 – HNO3, 4°; 4 – NaOH, 4°; 5 – NaOH/ZnAc, 4°; 6 – Na2S2O3, 4°; 7 – 4°

Matrix Codes: DW – Drinking Water; WW – Wastewater; GW – Groundwater; SW – Surface Water; ST – Storm Water; W – Water; S – Soil; SL – Sludge; SD – Sediment; SO – Solid; A – Air; L – Liquid; P – Product

Analysis Requested

Field Sample No./Identification	Date	Time	COMP	GRAB	Sample Container (Size/Mat'l)	Matrix	Preserv.	Field Filtered	PCB Analysis	Lab I.D.	Remarks
APG-18/19A	10/5/11	2015			20 mL Vial	Tissue	Ice		X		
APG-18/19B	10/7/11	1300			↓	↓	↓		↓		
APG-20/21A	10/6/11	1500			↓	↓	↓		↓		
APG-20/21B	10/7/11	1150			↓	↓	↓		↓		
APG-22/23A	10/5/11	1000			↓	↓	↓		↓		
APG-22/23B	10/7/11	1515			↓	↓	↓		↓		

Relinquished by: (Print Name)/(Affiliation)	Date/Time	Received by: (Print Name)/(Affiliation)	Date/Time
Christina Needham / AECOM Signature: Christina Needham	Date: 10/~~8~~ 10/11 ① Time:	Signature:	Date: Time:
Signature:	Date: Time:	Signature:	Date: Time:
Signature:	Date: Time:	Signature:	Date: Time:

Analytical Laboratory (Destination):

~~AECOM Toxicology Lab~~
~~4303 W. Laporte Avenue~~
~~Fort Collins, CO 80521~~
~~(970) 416-0916~~
~~(970) 490-2963 (FAX)~~

University of New Hampshire

Sample Shipped Via: UPS FedEx Courier Other

Temp blank: Yes No

① 10/10/11 E CN

O:\GRAPHICS\FORMS\Chain of Custody (COC)\Chain-of-Custody_Ft. Collins_10_07.doc

Serial No. № 51659

AECOM

CHAIN OF CUSTODY RECORD

Client/Project Name: 445	Project Location: FCETL | AECOM	Analysis Requested
Project Number: 60147216-445-(021-025)	Field Logbook No.:	
Sampler (Print Name)/(Affiliation): Christina Needham | AECOM	Chain of Custody Tape Nos.: 42630	
Signature: Christina Needham	Send Results/Report to: Rami Naddy — TAT: Std	

Container Type: P – Plastic; A – Amber Glass; G – Clear Glass; V – VOA Vial; O – Other; E – Encore

Preservation: 1 – HCl, 4°; 2 – H2SO4, 4°; 3 – HNO3, 4°; 4 – NaOH, 4°; 5 – NaOH/ZnAc, 4°; 6 – Na2S2O3, 4°; 7 – 4°

Matrix Codes: DW – Drinking Water; WW – Wastewater; GW – Groundwater; SW – Surface Water; ST – Storm Water; W – Water; S – Soil; SL – Sludge; SD – Sediment; SO – Solid; A – Air; L – Liquid; P – Product

Field Sample No./Identification	Date	Time	COMP	GRAB	Sample Container (Size/Mat'l)	Matrix	Preserv.	Field Filtered	PCB Analysis	Lab I.D.	Remarks
Form Sed A	10/12/11	1445			20 mL vial	Tissue	ice		X		
Form Sed B	10/11/11	1150			↓	↓	↓		↓		
APG-01/03A	10/12/11	1620			↓	↓	↓		↓		
APG-01/03B	10/11/11	1450			↓	↓	↓		↓		
APG-06/24A	10/12/11	1540			↓	↓	↓		↓		
APG-06/24 B	10/11/11	1700			↓	↓	↓		↓		
APG-11/13 A	10/12/11	1410			↓	↓	↓		↓		
APG-11/13 B	10/11/11	1545			↓	↓	↓		↓		
APG-12/15A	10/12/11	1710			↓	↓	↓		↓		
APG-12/15B	10/11/11	1045			↓	↓	↓		↓		
Lot # 11-018 @ Test initiation	9/13/11	1100			↓	↓	↓		↓		

Relinquished by: (Print Name)/(Affiliation)	Date/Time	Received by: (Print Name)/(Affiliation)	Date/Time
Andrea Sternenberger Signature: Andrea Sternenberger	Date: 10/17/11 Time: 1115	Signature:	Date: Time:
Signature:	Date: Time:	Signature:	Date: Time:
Signature:	Date: Time:	Signature:	Date: Time:

Analytical Laboratory (Destination):
~~AECOM Toxicology Lab~~
~~4303 W. Laporte Avenue~~
~~Fort Collins, CO 80521~~
~~(970) 416-0916~~
~~(970) 490-2963 (FAX)~~
University of New Hampshire

Sample Shipped Via: UPS FedEx Courier Other

Temp blank: Yes No

Serial No. № 51684

Appendix D: Statistical Outputs

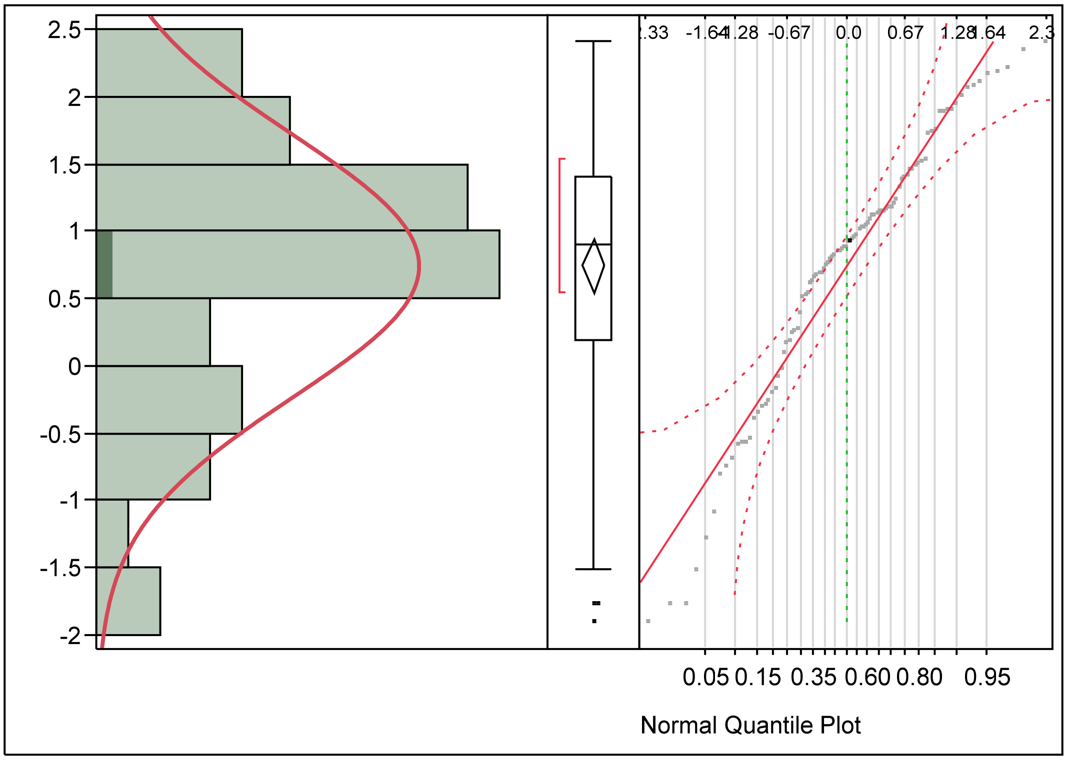
Bulk Soil Concentration

Statistical Evaluations

(all concentrations required logarithmic transformations)

<u>**Demonstration of Relative Normal Distribution for Log Bulk Soil Concentration Data**</u>

Log Bulk Soil Conc.



Normal(0.74909,0.97903)

Quantiles

100.0%	maximum	2.42
99.5%		2.42
97.5%		2.29825
90.0%		1.966
75.0%	quartile	1.405
50.0%	median	0.9085
25.0%	quartile	0.19175
10.0%		-0.585
2.5%		-1.77
0.5%		-1.9
0.0%	minimum	-1.9

Summary Statistics

Mean	0.7490908
Std Dev	0.9790328
Std Err Mean	0.0988972
Upper 95% Mean	0.9453745
Lower 95% Mean	0.5528072
N	98

Fitted Normal

Parameter Estimates

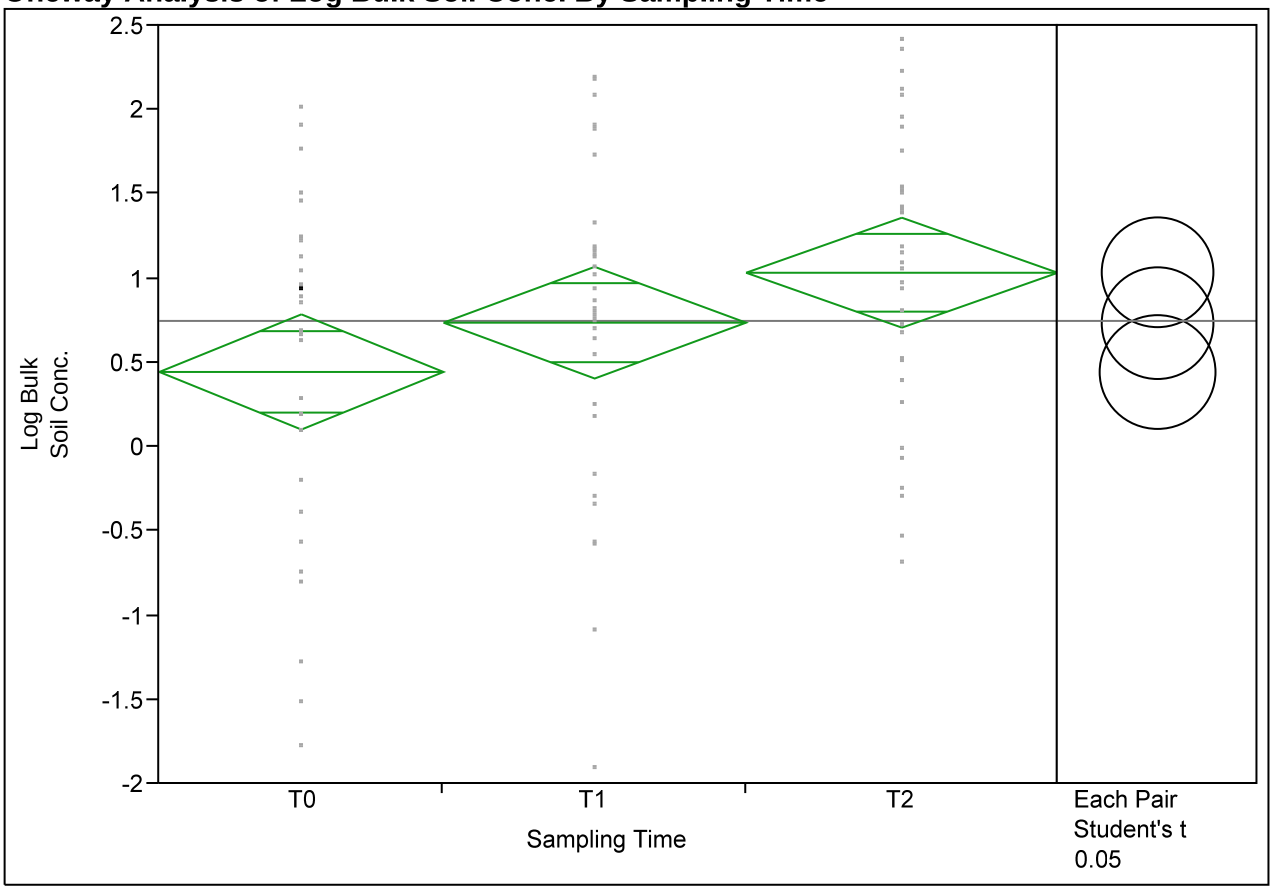
Type	Parameter	Estimate	Lower 95%	Upper 95%
Location	μ	0.7490908	0.5528072	0.9453745
Dispersion	σ	0.9790328	0.8585275	1.139202

-2log(Likelihood) = 272.958685157523

ANOVA: Bulk Soil Concentration Evaluation between Sampling Events

This ANOVA statistical analysis compared the bulk soil concentrations between the three sampling events across the greater treatment area. Analysis determined that bulk soil concentrations between T0 and T2 was **weakly significantly** depending upon the sampling event.

Oneway Analysis of Log Bulk Soil Conc. By Sampling Time



Oneway Anova
Summary of Fit

Rsquare	0.060507
Adj Rsquare	0.040728
Root Mean Square Error	0.958889
Mean of Response	0.749091
Observations (or Sum Wgts)	98

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Sampling Time	2	5.625608	2.81280	3.0592	0.0516
Error	95	87.349398	0.91947		
C. Total	97	92.975006			

Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
T0	31	0.44653	0.17222	0.10463	0.7884
T1	33	0.73848	0.16692	0.40710	1.0699
T2	34	1.03525	0.16445	0.70878	1.3617

Std Error uses a pooled estimate of error variance

Means Comparisons
Comparisons for each pair using Student's t
Confidence Quantile

t	Alpha
1.98525	0.05

LSD Threshold Matrix

Abs(Dif)-LSD	T2	T1	T0
T2	-0.46170	-0.16842	0.11598
T1	-0.16842	-0.46864	-0.18419
T0	0.11598	-0.18419	-0.48352

Positive values show pairs of means that are significantly different.

Connecting Letters Report

Level			Mean
T2	A		1.0352471
T1	A	B	0.7384848
T0		B	0.4465323

Levels not connected by same letter are significantly different.

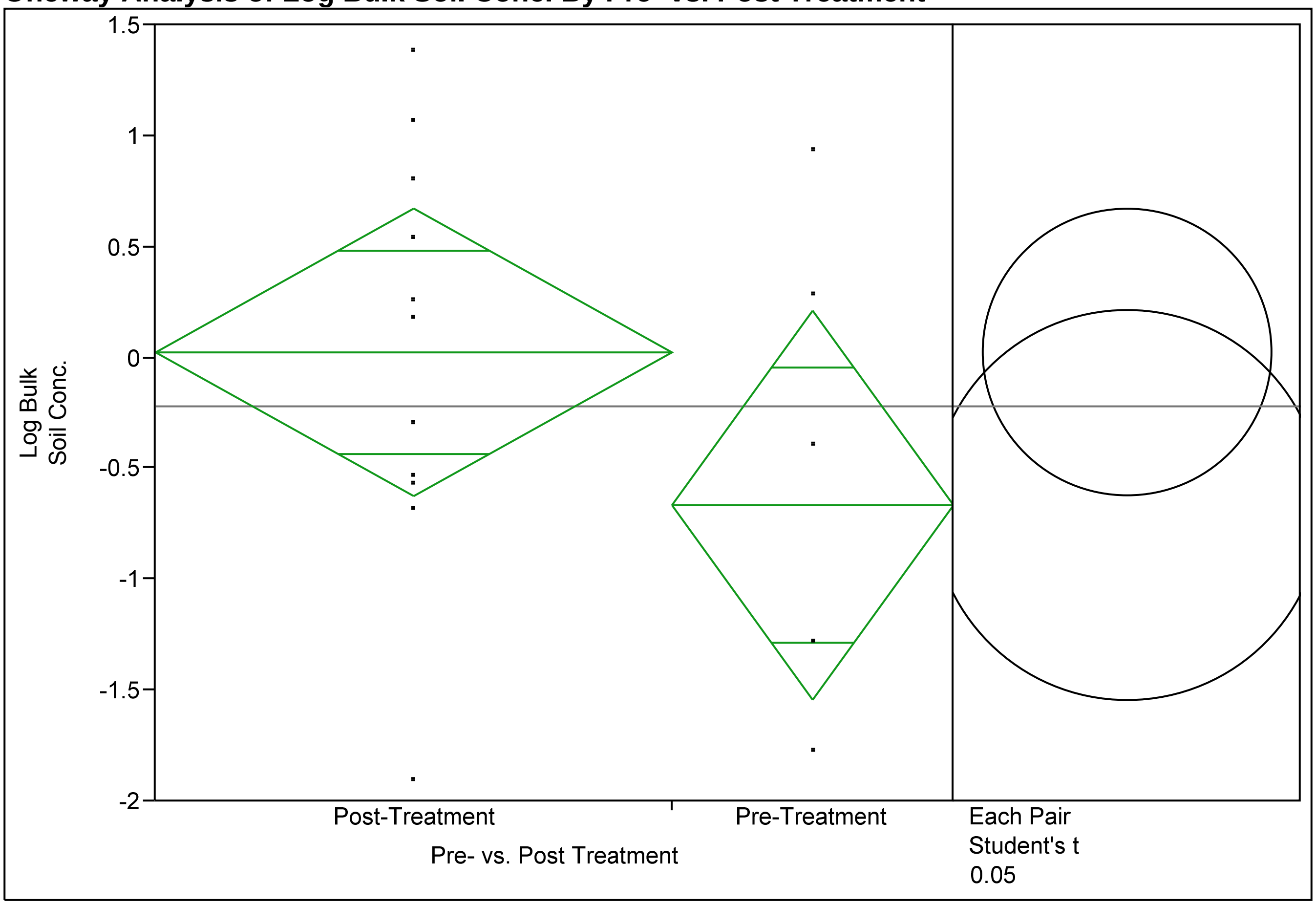
Ordered Differences Report

Level	- Level	Difference	Std Err Dif	Lower CL	Upper CL	p-Value
T2	T0	0.5887148	0.2381247	0.115977	1.061452	0.0152*
T2	T1	0.2967622	0.2343199	-0.168422	0.761946	0.2084
T1	T0	0.2919526	0.2398393	-0.184189	0.768094	0.2265

ANOVA: Bulk Soil Concentration Evaluation between Pre- and Post-Treatment for *AC Slurry Spray Plots*

This ANOVA statistical analysis compared just the bulk soil concentrations data between pre- and post-treatment sampling periods within the Slurry Spray (AC Slurry) Plots. Analysis determined that the pre- and post-treatment bulk soil concentrations were **not** significantly different.

Oneway Analysis of Log Bulk Soil Conc. By Pre- vs. Post Treatment



Excluded Rows
81

Oneway Anova

Summary of Fit

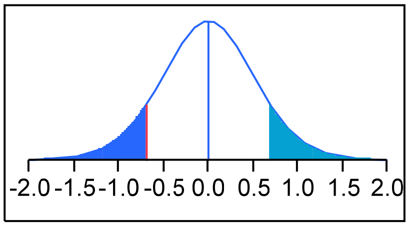
Rsquare	0.107863
Adj Rsquare	0.048387
Root Mean Square Error	1.008628
Mean of Response	-0.21794
Observations (or Sum Wgts)	17

t Test

Pre-Treatment-Post-Treatment

Assuming equal variances

Difference	-0.6894	t Ratio	-1.34668
Std Err Dif	0.5119	DF	15
Upper CL Dif	0.4017	Prob > |t|	0.1981
Lower CL Dif	-1.7804	Prob > t	0.9010
Confidence	0.95	Prob < t	0.0990



Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Pre- vs. Post Treatment	1	1.844980	1.84498	1.8136	0.1981
Error	15	15.259947	1.01733		
C. Total	16	17.104927			

Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
Post-Treatment	11	0.02536	0.30411	-0.623	0.67356
Pre-Treatment	6	-0.66400	0.41177	-1.542	0.21367

Std Error uses a pooled estimate of error variance

Means Comparisons
Comparisons for each pair using Student's t
Confidence Quantile

t	Alpha
2.13145	0.05

LSD Threshold Matrix

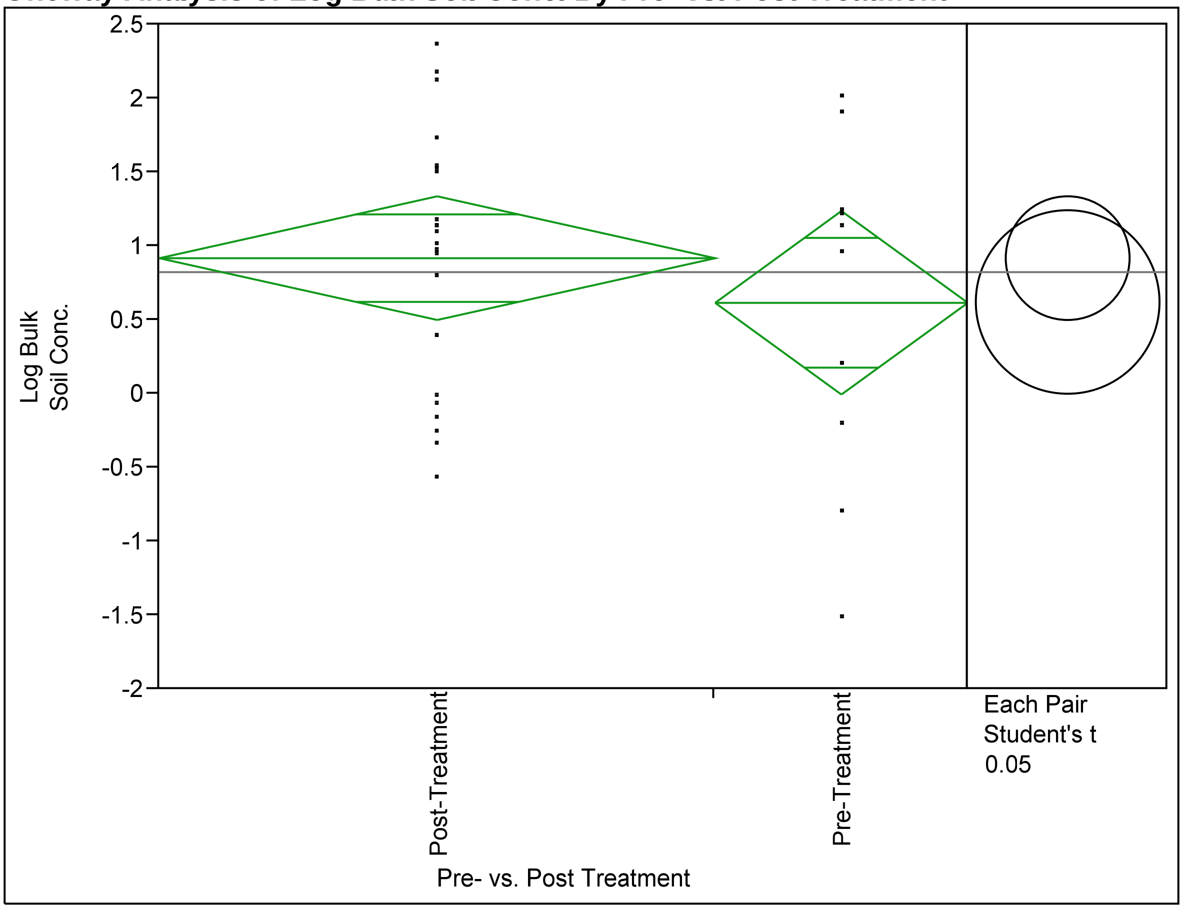
Abs(Dif)-LSD	Post-Treatment	Pre-Treatment
Post-Treatment	-0.9167	-0.4017
Pre-Treatment	-0.4017	-1.2412

Positive values show pairs of means that are significantly different.

ANOVA: Bulk Soil Concentration Evaluation between Pre- and Post-Treatment for *AquaBlok*

This ANOVA statistical analysis compared just the bulk soil concentrations data between pre- and post-treatment sampling periods within the AquaBlok Plots. Analysis determined that the pre- and post-treatment bulk soil concentrations were **not** significantly different.

Oneway Analysis of Log Bulk Soil Conc. By Pre- vs. Post Treatment



Excluded Rows
66

Oneway Anova

Summary of Fit

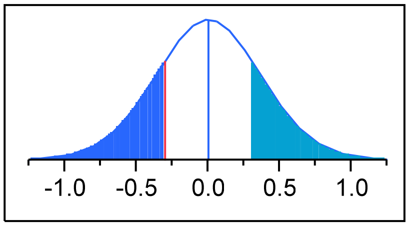
Rsquare	0.02216
Adj Rsquare	-0.01043
Root Mean Square Error	0.962255
Mean of Response	0.824138
Observations (or Sum Wgts)	32

t Test

Pre-Treatment-Post-Treatment

Assuming equal variances

Difference	-0.3026	t Ratio	-0.82455
Std Err Dif	0.3670	DF	30
Upper CL Dif	0.4469	Prob > |t|	0.4161
Lower CL Dif	-1.0521	Prob > t	0.7919
Confidence	0.95	Prob < t	0.2081



Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Pre- vs. Post Treatment	1	0.629521	0.629521	0.6799	0.4161
Error	30	27.778069	0.925936		
C. Total	31	28.407590			

Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
Post-Treatment	22	0.918700	0.20515	0.4997	1.3377
Pre-Treatment	10	0.616100	0.30429	-0.0053	1.2375

Std Error uses a pooled estimate of error variance

Means Comparisons
Comparisons for each pair using Student's t
Confidence Quantile

t	Alpha
2.04227	0.05

LSD Threshold Matrix

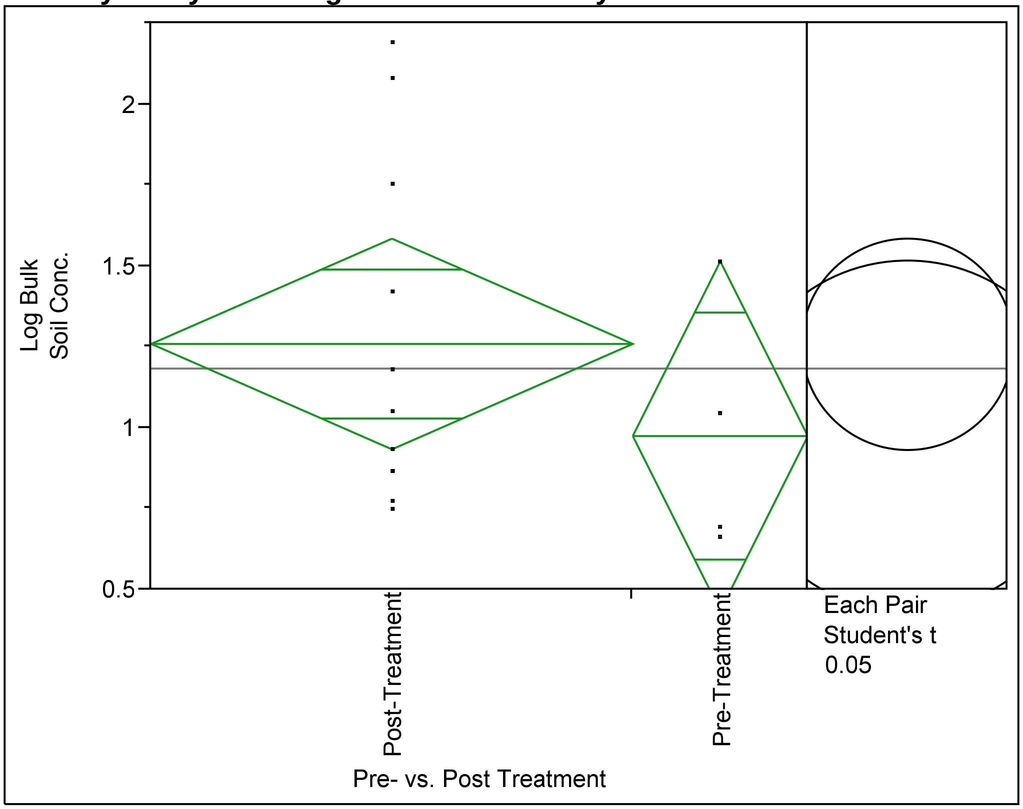
Abs(Dif)-LSD	Post-Treatment	Pre-Treatment
Post-Treatment	-0.59253	-0.44689
Pre-Treatment	-0.44689	-0.87886

Positive values show pairs of means that are significantly different.

ANOVA: Bulk Soil Concentration Evaluation between Pre- and Post-Treatment for *SediMite*

This ANOVA statistical analysis compared just the bulk soil concentrations data between pre- and post-treatment sampling periods within the SediMite Plots. Analysis determined that the pre- and post-treatment bulk soil concentrations were **not** significantly different.

Oneway Analysis of Log Bulk Soil Conc. By Pre- vs. Post Treatment



Excluded Rows
83

Oneway Anova

Summary of Fit

Rsquare	0.068123
Adj Rsquare	-0.00356
Root Mean Square Error	0.499831
Mean of Response	1.183133
Observations (or Sum Wgts)	15

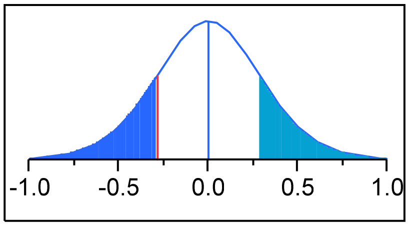
t Test

Pre-Treatment-Post-Treatment

Assuming equal variances

Difference	-0.28450	t Ratio	-0.97485
Std Err Dif	0.29184	DF	13

Upper CL Dif	0.34598	Prob > |t|	0.3474
Lower CL Dif	-0.91498	Prob > t	0.8263
Confidence	0.95	Prob < t	0.1737



Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Pre- vs. Post Treatment	1	0.2374247	0.237425	0.9503	0.3474
Error	13	3.2478090	0.249831		
C. Total	14	3.4852337			

Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
Post-Treatment	11	1.25900	0.15070	0.93342	1.5846
Pre-Treatment	4	0.97450	0.24992	0.43459	1.5144

Std Error uses a pooled estimate of error variance

Means Comparisons
Comparisons for each pair using Student's t
Confidence Quantile

t	Alpha
2.16037	0.05

LSD Threshold Matrix

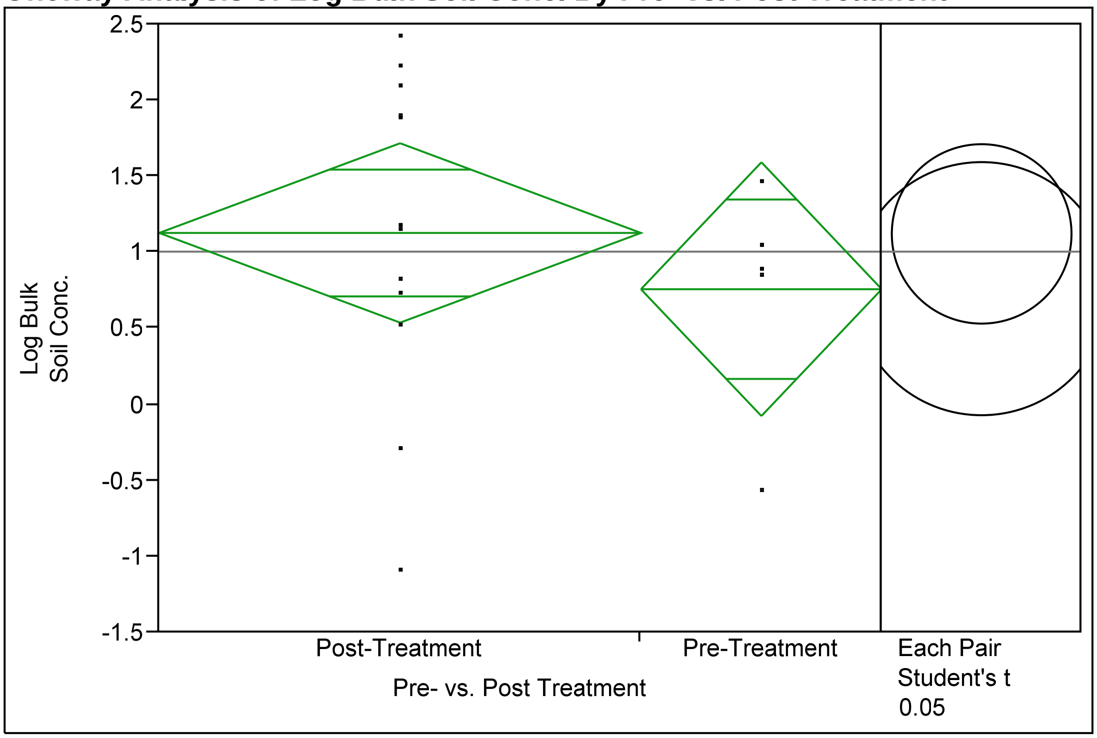
Abs(Dif)-LSD	Post-Treatment	Pre-Treatment
Post-Treatment	-0.46044	-0.34598
Pre-Treatment	-0.34598	-0.76355

Positive values show pairs of means that are significantly different.

ANOVA: Bulk Soil Concentration Evaluation between Pre- and Post-Treatment for *Sand Control*

This ANOVA statistical analysis compared just the bulk soil concentrations data between pre- and post-treatment sampling periods within the Sand Control Plots. Analysis determined that the pre- and post-treatment bulk soil concentrations were **not** significantly different.

Oneway Analysis of Log Bulk Soil Conc. By Pre- vs. Post Treatment



Excluded Rows
80

Oneway Anova

Summary of Fit

Rsquare	0.0354
Adj Rsquare	-0.02489
Root Mean Square Error	0.964831
Mean of Response	1.005778
Observations (or Sum Wgts)	18

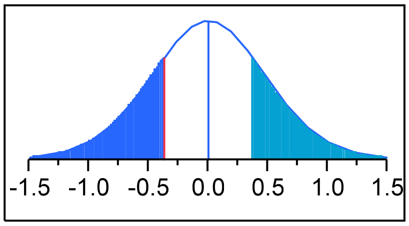
t Test

Pre-Treatment-Post-Treatment

Assuming equal variances

Difference	-0.3697	t Ratio	-0.76628
Std Err Dif	0.4824	DF	16
Upper CL Dif	0.6530	Prob > |t|	0.4547
Lower CL Dif	-1.3923	Prob > t	0.7727

Confidence	0.95	Prob < t	0.2273



Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Pre- vs. Post Treatment	1	0.546614	0.546614	0.5872	0.4547
Error	16	14.894373	0.930898		
C. Total	17	15.440987			

Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
Post-Treatment	12	1.12900	0.27852	0.5386	1.7194
Pre-Treatment	6	0.75933	0.39389	-0.0757	1.5943

Std Error uses a pooled estimate of error variance

Means Comparisons
Comparisons for each pair using Student's t
Confidence Quantile

t	Alpha
2.11991	0.05

LSD Threshold Matrix

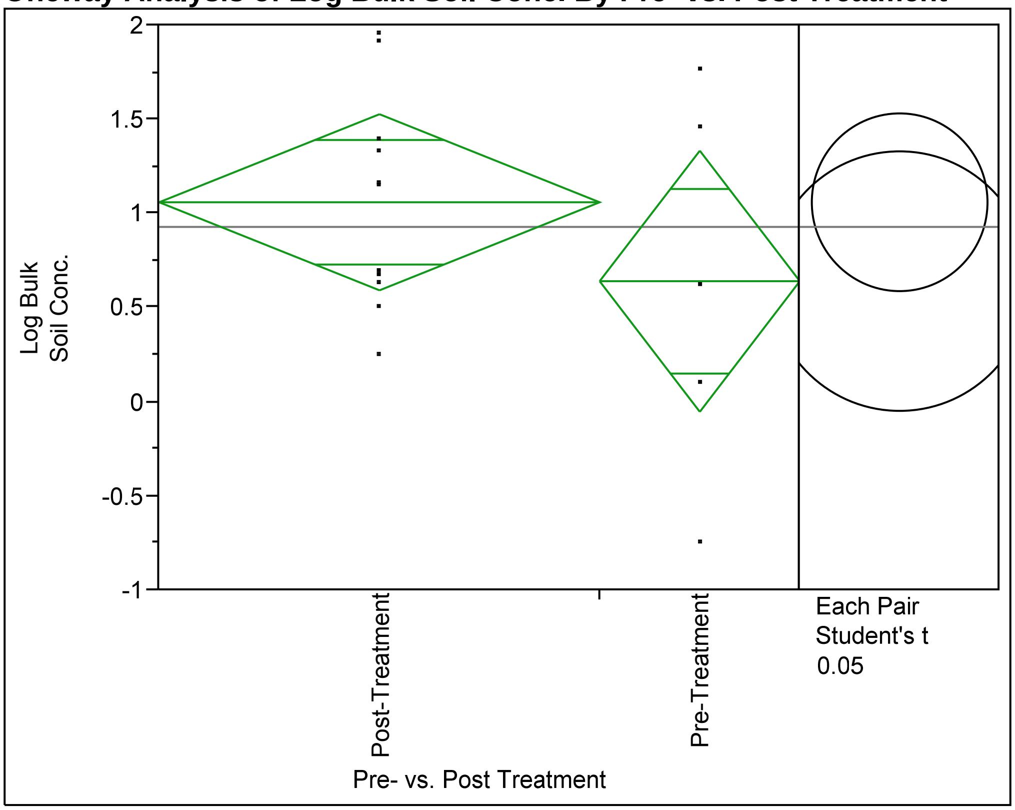
Abs(Dif)-LSD	Post-Treatment	Pre-Treatment
Post-Treatment	-0.8350	-0.6530
Pre-Treatment	-0.6530	-1.1809

Positive values show pairs of means that are significantly different.

<u>ANOVA: Bulk Soil Concentration Evaluation between Pre- and Post-Treatment for *Control*</u>

This ANOVA statistical analysis compared just the bulk soil concentrations data between pre- and post-treatment sampling periods within the Control Plots. Analysis determined that the pre- and post-treatment bulk soil concentrations were **<u>not</u>** significantly different.

Oneway Analysis of Log Bulk Soil Conc. By Pre- vs. Post Treatment



Excluded Rows
82

Oneway Anova

Summary of Fit

Rsquare	0.076435
Adj Rsquare	0.010466
Root Mean Square Error	0.722751
Mean of Response	0.930781
Observations (or Sum Wgts)	16

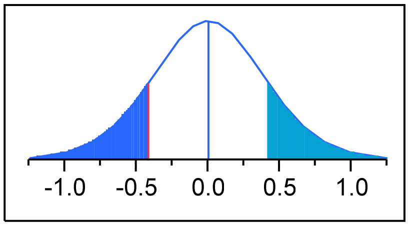
t Test

Pre-Treatment-Post-Treatment

Assuming equal variances

Difference	-0.4196	t Ratio	-1.07641

Std Err Dif	0.3898	DF	14
Upper CL Dif	0.4165	Prob > |t|	0.2999
Lower CL Dif	-1.2557	Prob > t	0.8500
Confidence	0.95	Prob < t	0.1500



Analysis of Variance

Source	**DF**	**Sum of Squares**	**Mean Square**	**F Ratio**	**Prob > F**
Pre- vs. Post Treatment	1	0.6052468	0.605247	1.1587	0.2999
Error	14	7.3131677	0.522369		
C. Total	15	7.9184145			

Means for Oneway Anova

Level	**Number**	**Mean**	**Std Error**	**Lower 95%**	**Upper 95%**
Post-Treatment	11	1.06191	0.21792	0.5945	1.5293
Pre-Treatment	5	0.64230	0.32322	-0.0509	1.3355

Std Error uses a pooled estimate of error variance

Means Comparisons
Comparisons for each pair using Student's t
Confidence Quantile

t	**Alpha**
2.14479	0.05

LSD Threshold Matrix

Abs(Dif)-LSD	**Post-Treatment**	**Pre-Treatment**
Post-Treatment	-0.66098	-0.41648
Pre-Treatment	-0.41648	-0.98040

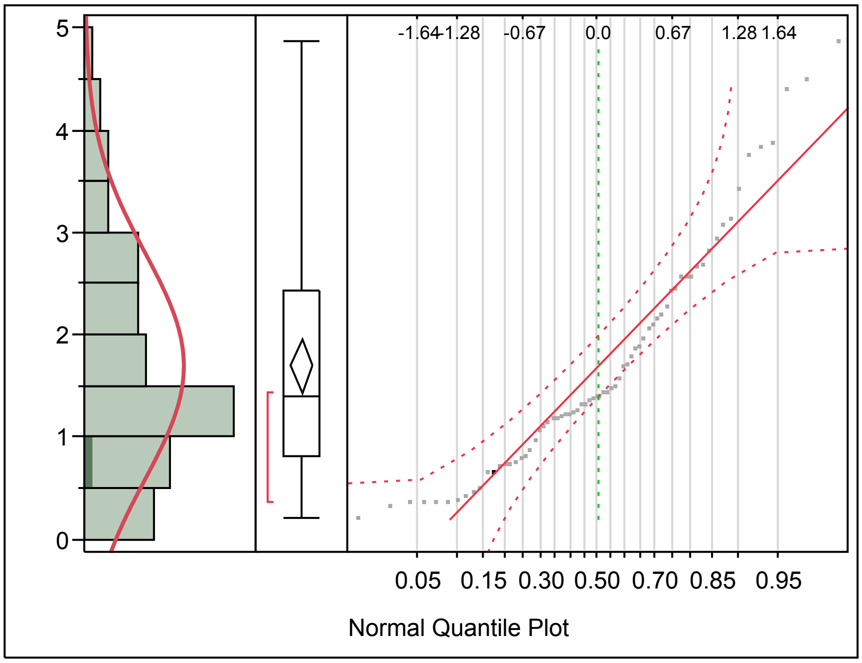
Positive values show pairs of means that are significantly different.

Black Carbon

Statistical Evaluations

Demonstration of Relative Normal Distribution for %BC Data

Distributions BC %



Normal(1.70367,1.10768)

Quantiles

100.0%	maximum	4.86748
99.5%		4.86748
97.5%		4.58062
90.0%		3.39877
75.0%	quartile	2.43649
50.0%	median	1.397
25.0%	quartile	0.81254
10.0%		0.38913
2.5%		0.29552
0.5%		0.202
0.0%	minimum	0.202

Summary Statistics

Mean	1.7036713
Std Dev	1.1076825
Std Err Mean	0.1323934
Upper 95% Mean	1.9677889
Lower 95% Mean	1.4395537
N	70

Fitted Normal

Parameter Estimates

Type	Parameter	Estimate	Lower 95%	Upper 95%

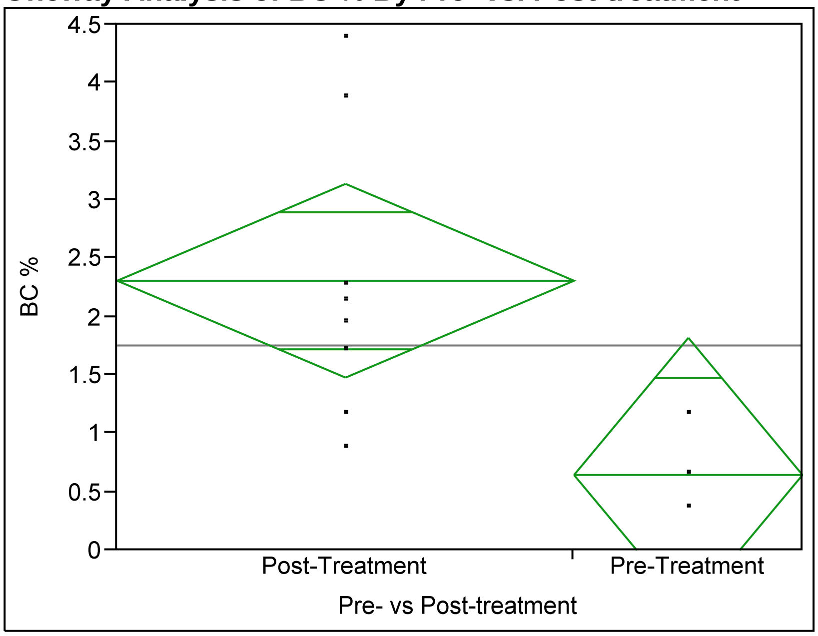
Type	Parameter	Estimate	Lower 95%	Upper 95%
Location	μ	1.7036713	1.4395537	1.9677889
Dispersion	σ	1.1076825	0.9497465	1.329115

-2log(Likelihood) = 211.969188742444

ANOVA: %BC Evaluation between Pre- and Post-Treatment for *AC Slurry Spray*

This ANOVA statistical analysis compared just the Percent Black Carbon data between pre- and post-treatment sampling periods within the Slurry Spray (AC Slurry) Plots. Analysis determined that the pre- and post-treatment %BC values were significantly different.

Oneway Analysis of BC % By Pre- vs. Post-treatment



Excluded Rows
58

Oneway Anova

Summary of Fit

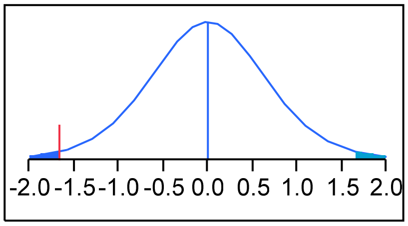
Rsquare	0.39911
Adj Rsquare	0.339021
Root Mean Square Error	1.053379
Mean of Response	1.754081
Observations (or Sum Wgts)	12

t Test

Pre-Treatment-Post-Treatment

Assuming equal variances

Difference	-1.6625	t Ratio	-2.5772
Std Err Dif	0.6451	DF	10
Upper CL Dif	-0.2252	Prob > |t|	0.0275*
Lower CL Dif	-3.0997	Prob > t	0.9862
Confidence	0.95	Prob < t	0.0138*



Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Pre- vs. Post-treatment	1	7.369989	7.36999	6.6420	0.0275*
Error	10	11.096068	1.10961		
C. Total	11	18.466057			

Means for Oneway Anova

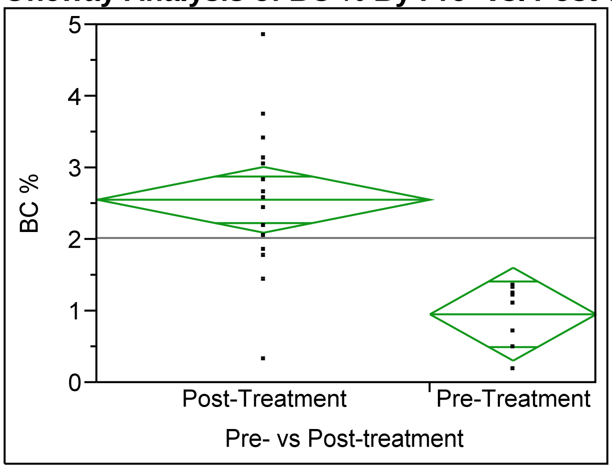
Level	Number	Mean	Std Error	Lower 95%	Upper 95%
Post-Treatment	8	2.30823	0.37243	1.478	3.1380
Pre-Treatment	4	0.64578	0.52669	-0.528	1.8193

Std Error uses a pooled estimate of error variance

ANOVA: %BC Evaluation between Pre- and Post-Treatment for *AquaBlok*

This ANOVA statistical analysis compared just the Percent Black Carbon data between pre- and post-treatment sampling periods within the AquaBlok Plots. Analysis determined that the pre- and post-treatment %BC values were significantly different.

Oneway Analysis of BC % By Pre- vs. Post-treatment



Excluded Rows
46

Oneway Anova

Summary of Fit

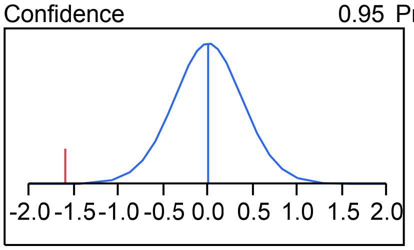
Rsquare	0.441689
Adj Rsquare	0.416311
Root Mean Square Error	0.885353
Mean of Response	2.027863
Observations (or Sum Wgts)	24

t Test

Pre-Treatment-Post-Treatment

Assuming equal variances

Difference	-1.5994	t Ratio	-4.17187
Std Err Dif	0.3834	DF	22
Upper CL Dif	-0.8043	Prob > |t|	0.0004*
Lower CL Dif	-2.3944	Prob > t	0.9998
Confidence	0.95	Prob < t	0.0002*



Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Pre- vs. Post-treatment	1	13.642559	13.6426	17.4045	0.0004*
Error	22	17.244714	0.7839		
C. Total	23	30.887273			

Means for Oneway Anova

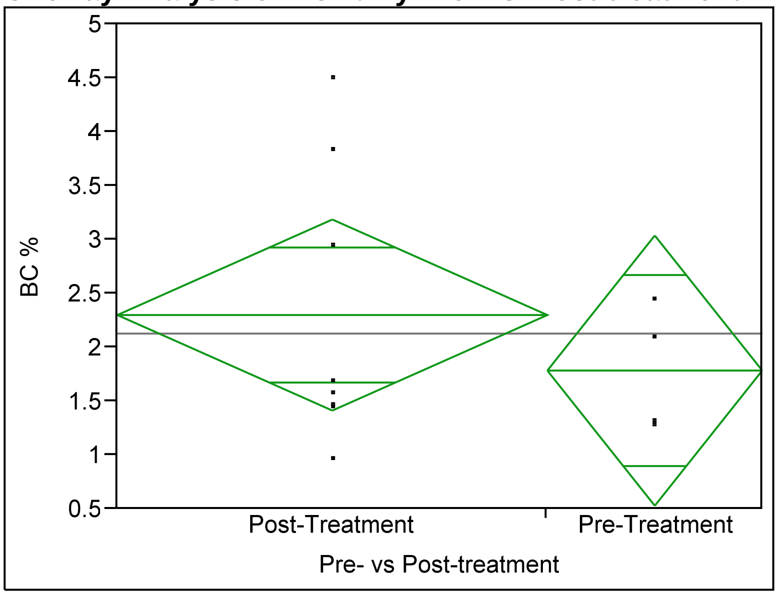
Level	Number	Mean	Std Error	Lower 95%	Upper 95%
Post-Treatment	16	2.56099	0.22134	2.1020	3.0200
Pre-Treatment	8	0.96162	0.31302	0.3125	1.6108

Std Error uses a pooled estimate of error variance

ANOVA: %BC Evaluation between Pre- and Post-Treatment for *SediMite*

This ANOVA statistical analysis compared just the Percent Black Carbon data between pre- and post-treatment sampling periods within the SediMite Plots. Analysis determined that the pre- and post-treatment %BC values were **not** significantly different.

Oneway Analysis of BC % By Pre- vs. Post-treatment



Excluded Rows
58

Oneway Anova

Summary of Fit

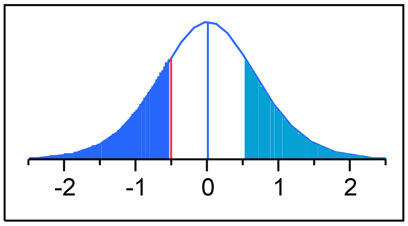
Rsquare	0.052989
Adj Rsquare	-0.04171
Root Mean Square Error	1.126175
Mean of Response	2.128919
Observations (or Sum Wgts)	12

t Test

Pre-Treatment-Post-Treatment

Assuming equal variances

Difference	-0.5159	t Ratio	-0.74802
Std Err Dif	0.6896	DF	10
Upper CL Dif	1.0207	Prob > |t|	0.4717
Lower CL Dif	-2.0525	Prob > t	0.7642
Confidence	0.95	Prob < t	0.2358



Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Pre- vs. Post-treatment	1	0.709641	0.70964	0.5595	0.4717
Error	10	12.682708	1.26827		
C. Total	11	13.392349			

Means for Oneway Anova

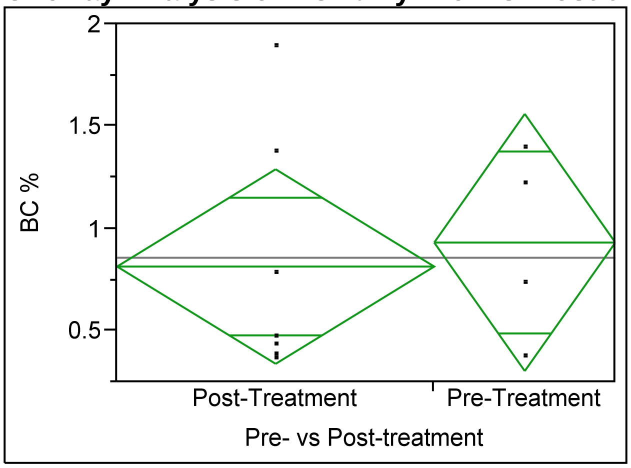
Level	Number	Mean	Std Error	Lower 95%	Upper 95%
Post-Treatment	8	2.30087	0.39816	1.4137	3.1880
Pre-Treatment	4	1.78501	0.56309	0.5304	3.0396

Std Error uses a pooled estimate of error variance

ANOVA: %BC Evaluation between Pre- and Post-Treatment for *Sand Control*

This ANOVA statistical analysis compared just the Percent Black Carbon data between pre- and post-treatment sampling periods within the Sand Control Plots. Analysis determined that the pre- and post-treatment %BC values were **not** significantly different.

Oneway Analysis of BC % By Pre- vs. Post-treatment



Excluded Rows
59

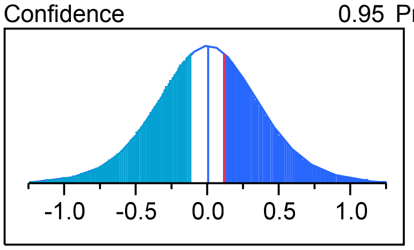
Oneway Anova
Summary of Fit

Rsquare	0.012479
Adj Rsquare	-0.09725
Root Mean Square Error	0.555812
Mean of Response	0.858601
Observations (or Sum Wgts)	11

t Test
Pre-Treatment-Post-Treatment

Assuming equal variances

Difference	0.11749	t Ratio	0.337239
Std Err Dif	0.34837	DF	9
Upper CL Dif	0.90556	Prob > |t|	0.7437
Lower CL Dif	-0.67059	Prob > t	0.3718
Confidence	0.95	Prob < t	0.6282



Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F

Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Pre- vs. Post-treatment	1	0.0351344	0.035134	0.1137	0.7437
Error	9	2.7803432	0.308927		
C. Total	10	2.8154776			

Means for Oneway Anova

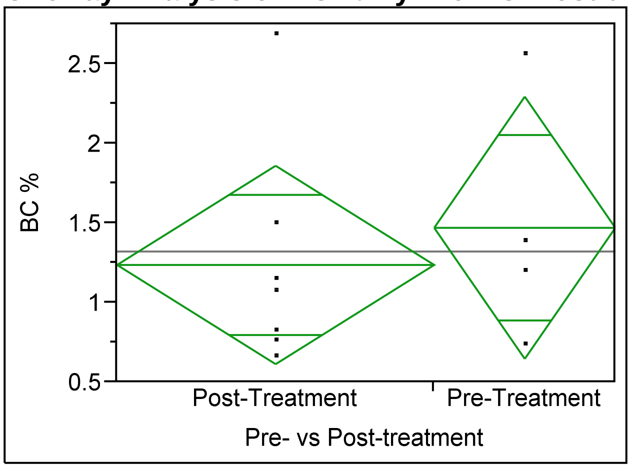
Level	Number	Mean	Std Error	Lower 95%	Upper 95%
Post-Treatment	7	0.815879	0.21008	0.34065	1.2911
Pre-Treatment	4	0.933364	0.27791	0.30470	1.5620

Std Error uses a pooled estimate of error variance

ANOVA: %BC Evaluation between Pre- and Post-Treatment within Control Plots

This ANOVA statistical analysis compared just the Percent Black Carbon data between pre- and post-treatment sampling periods within the Control Plots. Analysis determined that the pre- and post-treatment %BC values were **not** significantly different.

Oneway Analysis of BC % By Pre- vs. Post-treatment



Excluded Rows
59

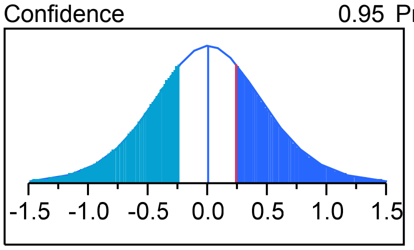
Oneway Anova
Summary of Fit

Rsquare	0.028278
Adj Rsquare	-0.07969
Root Mean Square Error	0.729026
Mean of Response	1.322515
Observations (or Sum Wgts)	11

t Test
Pre-Treatment-Post-Treatment

Assuming equal variances

Difference	0.2339	t Ratio	0.511774
Std Err Dif	0.4569	DF	9
Upper CL Dif	1.2675	Prob > |t|	0.6211
Lower CL Dif	-0.7998	Prob > t	0.3106
Confidence	0.95	Prob < t	0.6894



Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F

Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Pre- vs. Post-treatment	1	0.1392011	0.139201	0.2619	0.6211
Error	9	4.7833143	0.531479		
C. Total	10	4.9225154			

Means for Oneway Anova

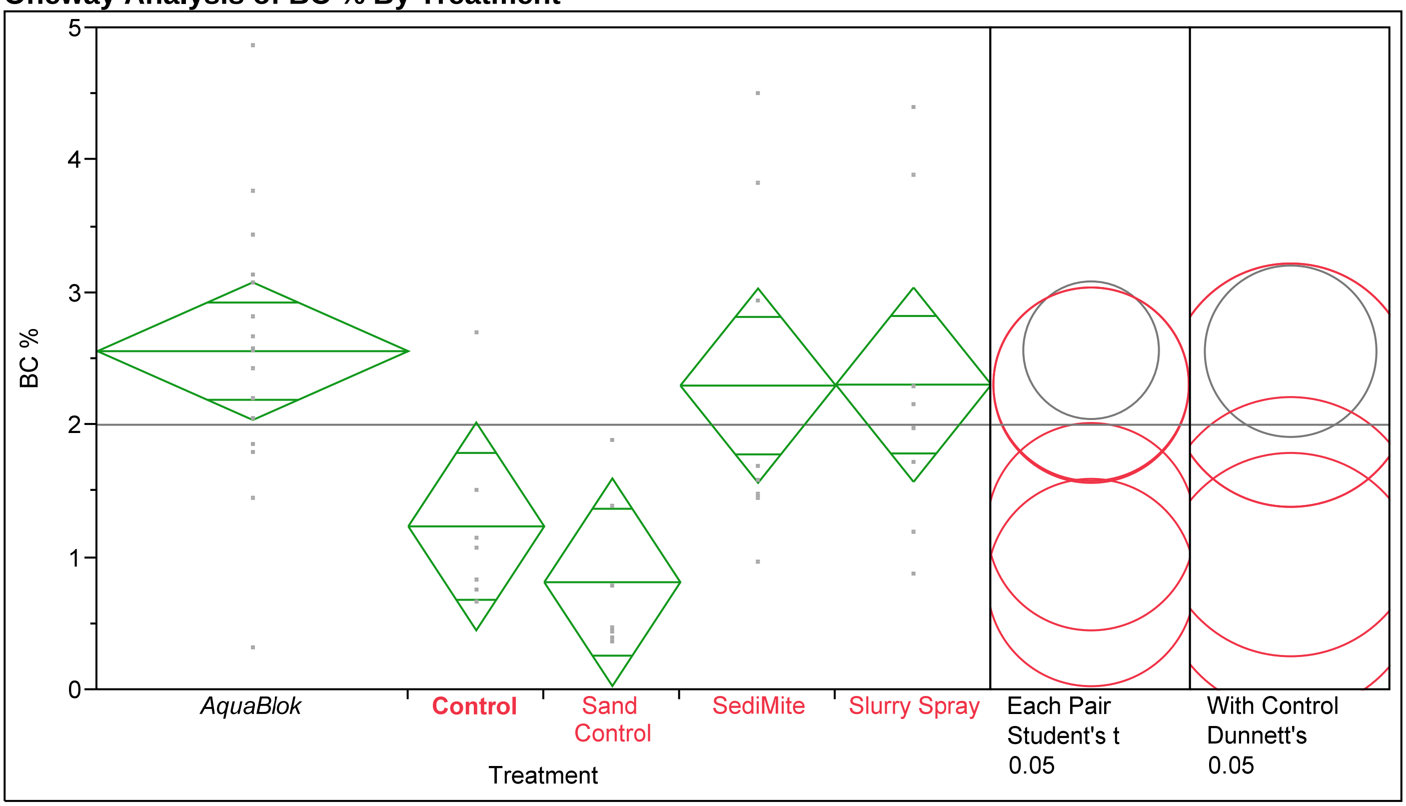
Level	Number	Mean	Std Error	Lower 95%	Upper 95%
Post-Treatment	7	1.23748	0.27555	0.61415	1.8608
Pre-Treatment	4	1.47133	0.36451	0.64674	2.2959

Std Error uses a pooled estimate of error variance

ANOVA: Post Treatment %BC evaluation of Various Treatments; Student's T Test: Determine Significance between Treatment Types; Control Dunnett's: Determine Significance between Control and All other Treatments

An ANOVA statistical analysis and Student's T means statistical comparison was conducted on all post-treatment %BC data by "Treatment Type" (AquaBlok, Control, Sand Control, SediMite and Slurry Spray (AC)). ANOVA determined that Treatment Type was a significant variable within the data set (for %BC). Student's T means statistical comparison determined that the AquaBlok was statistically separate from the Control. Dunnett's mean statistical comparison (with control set as the control) confirmed that AquaBlok was the only Treatment different than the control.

Oneway Analysis of BC % By Treatment



Excluded Rows
24

Oneway Anova
Summary of Fit

Rsquare	0.320085
Adj Rsquare	0.253751
Root Mean Square Error	1.028148
Mean of Response	2.004829
Observations (or Sum Wgts)	46

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Treatment	4	20.403541	5.10089	4.8254	0.0028*
Error	41	43.340653	1.05709		
C. Total	45	63.744194			

Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
AquaBlok	16	2.56099	0.25704	2.0419	3.0801
Control	7	1.23748	0.38860	0.4527	2.0223
Sand Control	7	0.81588	0.38860	0.0311	1.6007
SediMite	8	2.30087	0.36351	1.5668	3.0350
Slurry Spray	8	2.30823	0.36351	1.5741	3.0423

Std Error uses a pooled estimate of error variance

Means Comparisons
Comparisons for each pair using Student's t
Confidence Quantile

t	Alpha
2.01954	0.05

LSD Threshold Matrix

Abs(Dif)-LSD	AquaBlok	Slurry Spray	SediMite	Control	Sand Control
AquaBlok	-0.7341	-0.6463	-0.6390	0.3826	0.8042
Slurry Spray	-0.6463	-1.0382	-1.0308	-0.0039	0.4177
SediMite	-0.6390	-1.0308	-1.0382	-0.0112	0.4104
Control	0.3826	-0.0039	-0.0112	-1.1099	-0.6883
Sand Control	0.8042	0.4177	0.4104	-0.6883	-1.1099

Positive values show pairs of means that are significantly different.

Connecting Letters Report

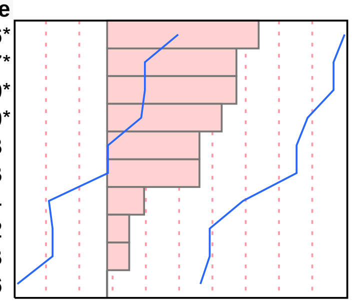
Level				Mean
AquaBlok	A			2.5609859
Slurry Spray	A	B		2.3082319
SediMite	A	B		2.3008737
Control		B	C	1.2374785
Sand Control			C	0.8158787

Levels not connected by same letter are significantly different.

Ordered Differences Report

Ordered Differences Report

Level	- Level	Difference	Std Err Dif	Lower CL	Upper CL	p-Value
AquaBlok	Sand Control	1.745107	0.4659193	0.80416	2.686050	0.0006*
Slurry Spray	Sand Control	1.492353	0.5321173	0.41772	2.566986	0.0077*
SediMite	Sand Control	1.484995	0.5321173	0.41036	2.559628	0.0079*
AquaBlok	Control	1.323507	0.4659193	0.38256	2.264450	0.0070*
Slurry Spray	Control	1.070753	0.5321173	-0.00388	2.145386	0.0508
SediMite	Control	1.063395	0.5321173	-0.01124	2.138028	0.0523
Control	Sand Control	0.421600	0.5495684	-0.68828	1.531476	0.4474
AquaBlok	SediMite	0.260112	0.4452013	-0.63899	1.159214	0.5622
AquaBlok	Slurry Spray	0.252754	0.4452013	-0.64635	1.151856	0.5733
Slurry Spray	SediMite	0.007358	0.5140742	-1.03084	1.045552	0.9886



Comparisons with a control using Dunnett's Method

Control Group =
Control

Confidence Quantile

|d|	Alpha
2.52104	0.05

LSD Threshold Matrix

Level	Abs(Dif)-LSD	p-Value
AquaBlok	0.149	0.0232*
Slurry Spray	-0.27	0.1480
SediMite	-0.28	0.1521
Control	-1.39	1.0000
Sand Control	-0.96	0.8422

Positive values show pairs of means that are significantly different.

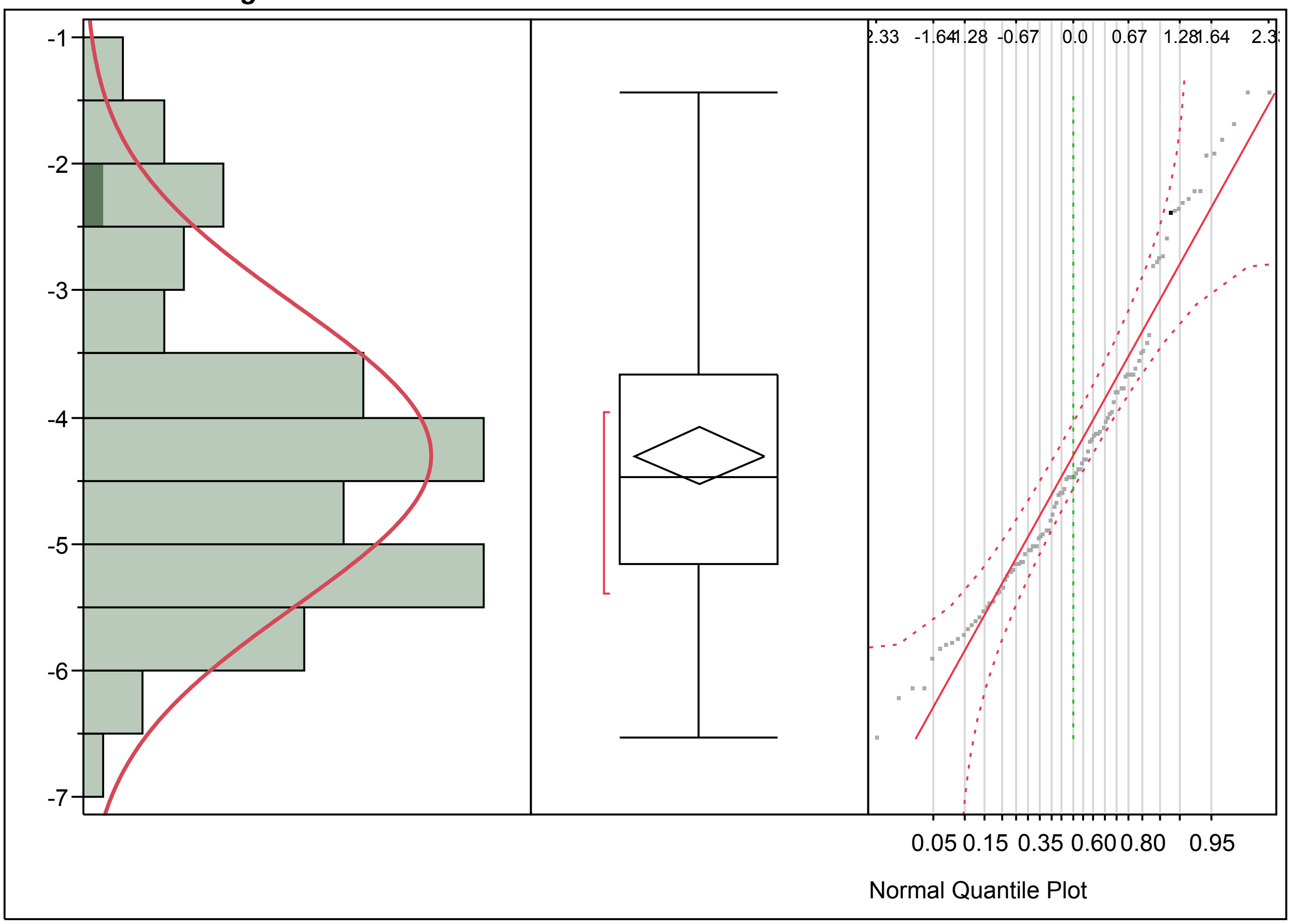
Pore Water Concentration

Statistical Evaluations

(all concentrations required logarithmic transformations)

Demonstration of Relative Normal Distribution for Log Pore Water Concentration Data

Distributions - Log Pore Water Conc.



Normal(-4.2968,1.1955)

Quantiles

100.0%	maximum	-1.43
99.5%		-1.43
97.5%		-1.59
90.0%		-2.335
75.0%	quartile	-3.67
50.0%	median	-4.47
25.0%	quartile	-5.1675
10.0%		-5.705
2.5%		-6.17
0.5%		-6.54
0.0%	minimum	-6.54

Summary Statistics

Mean	-4.296827

Std Dev	1.1955047
Std Err Mean	0.1172289
Upper 95% Mean	-4.064331
Lower 95% Mean	-4.529323
N	104

Fitted Normal

Parameter Estimates

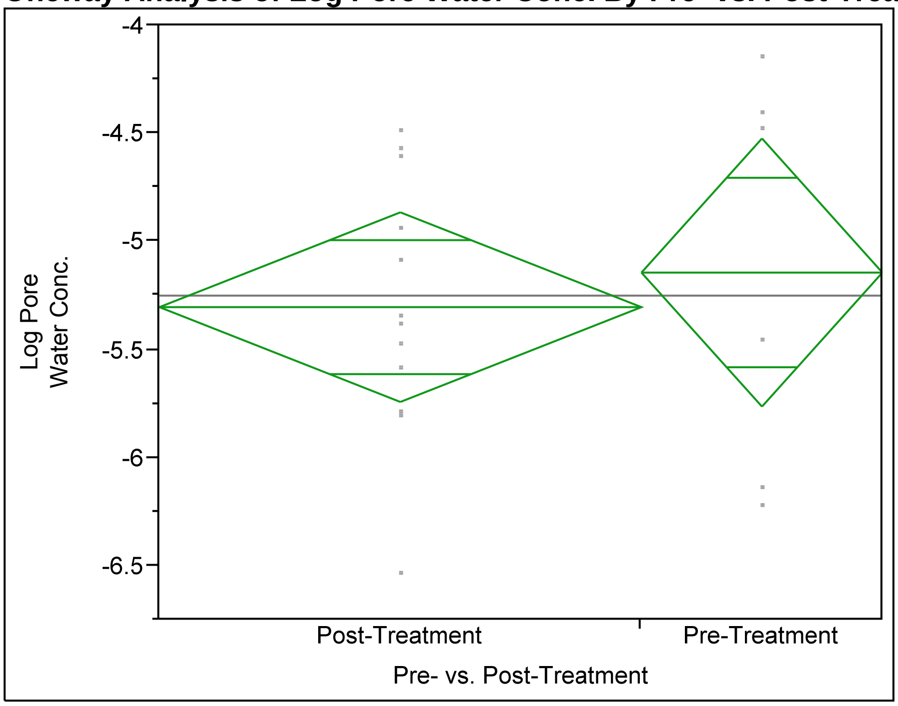
Type	Parameter	Estimate	Lower 95%	Upper 95%
Location	μ	-4.296827	-4.529323	-4.064331
Dispersion	σ	1.1955047	1.0521688	1.3844108

-2log(Likelihood) = 331.281457101605

<u>ANOVA: Pore Water Concentration Evaluation between Pre- and Post-Treatment for *AC Slurry Spray*</u>

This ANOVA statistical analysis compared just the pore water concentrations data between pre- and post-treatment sampling periods within the Slurry Spray (AC Slurry) Plots. Analysis determined that the pre- and post-treatment pore water concentrations were <u>**not**</u> significantly different.

Oneway Analysis of Log Pore Water Conc. By Pre- vs. Post-Treatment



Excluded Rows
86

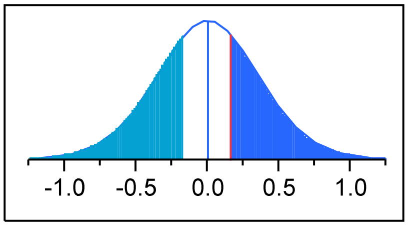
Oneway Anova
Summary of Fit

Rsquare	0.012305
Adj Rsquare	-0.04943
Root Mean Square Error	0.716729
Mean of Response	-5.25
Observations (or Sum Wgts)	18

t Test
Pre-Treatment-Post-Treatment

Assuming equal variances

Difference	0.16000	t Ratio	0.446473
Std Err Dif	0.35836	DF	16
Upper CL Dif	0.91970	Prob > |t|	0.6612
Lower CL Dif	-0.59970	Prob > t	0.3306
Confidence	0.95	Prob < t	0.6694



Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Pre- vs. Post-Treatment	1	0.1024000	0.102400	0.1993	0.6612
Error	16	8.2192000	0.513700		
C. Total	17	8.3216000			

Means for Oneway Anova

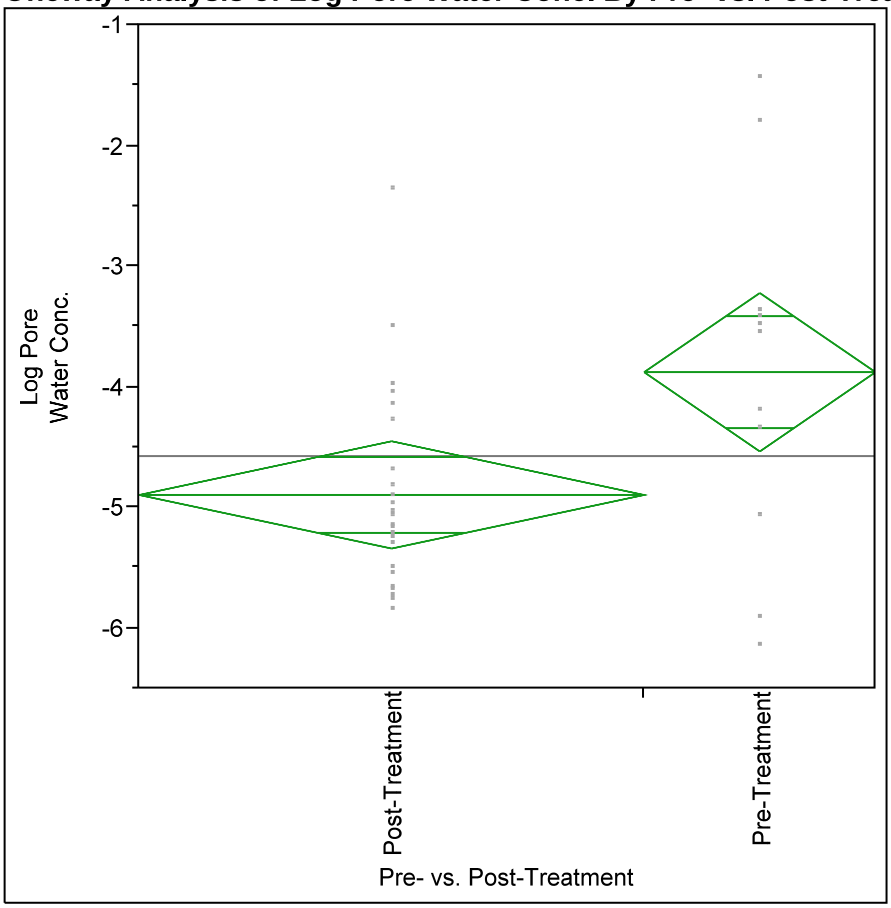
Level	Number	Mean	Std Error	Lower 95%	Upper 95%
Post-Treatment	12	-5.3033	0.20690	-5.742	-4.865
Pre-Treatment	6	-5.1433	0.29260	-5.764	-4.523

Std Error uses a pooled estimate of error variance

ANOVA: Pore Water Concentration Evaluation between Pre- and Post-Treatment for *AquaBlok*

This ANOVA statistical analysis compared just the pore water concentrations data between pre- and post-treatment sampling periods within the AquaBlok Plots. Analysis determined that the pre- and post-treatment pore water concentrations were significantly different.

Oneway Analysis of Log Pore Water Conc. By Pre- vs. Post-Treatment



Excluded Rows
69

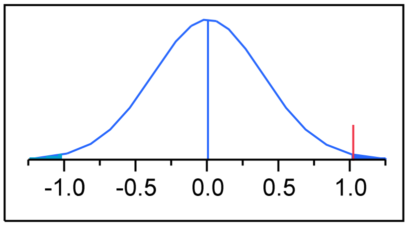
Oneway Anova
Summary of Fit

Rsquare	0.170864
Adj Rsquare	0.145738
Root Mean Square Error	1.071403
Mean of Response	-4.57486
Observations (or Sum Wgts)	35

t Test
Pre-Treatment-Post-Treatment

Assuming equal variances

Difference	1.01731	t Ratio	2.607767
Std Err Dif	0.39011	DF	33
Upper CL Dif	1.81099	Prob > |t|	0.0136*
Lower CL Dif	0.22363	Prob > t	0.0068*
Confidence	0.95	Prob < t	0.9932



Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Pre- vs. Post-Treatment	1	7.806260	7.80626	6.8005	0.0136*
Error	33	37.880814	1.14790		
C. Total	34	45.687074			

Means for Oneway Anova

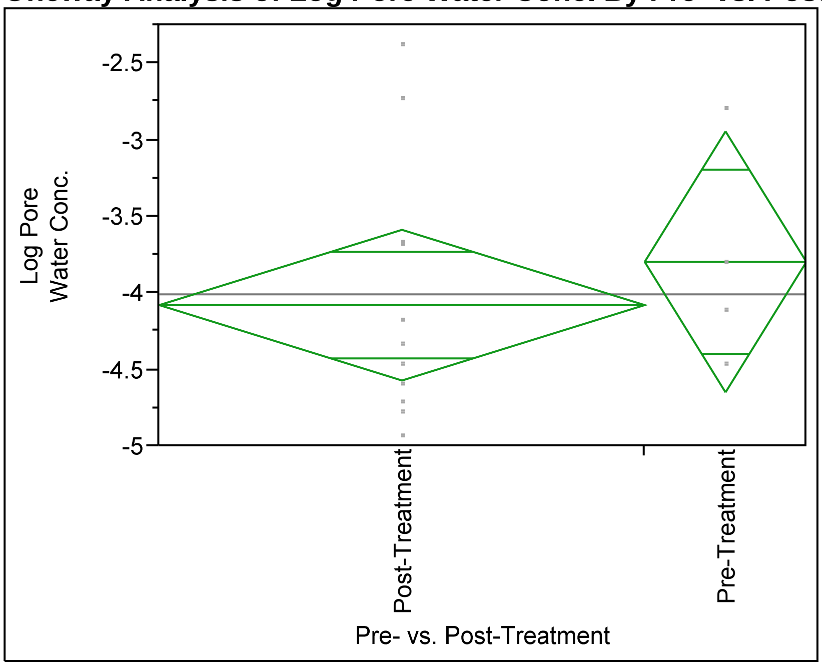
Level	Number	Mean	Std Error	Lower 95%	Upper 95%
Post-Treatment	24	-4.8946	0.21870	-5.340	-4.450
Pre-Treatment	11	-3.8773	0.32304	-4.535	-3.220

Std Error uses a pooled estimate of error variance

ANOVA: Pore Water Concentration Evaluation between Pre- and Post-Treatment for *SediMite*

This ANOVA statistical analysis compared just the pore water concentrations data between pre- and post-treatment sampling periods within the SediMite Plots. Analysis determined that the pre- and post-treatment pore water concentrations were **not** significantly different.

Oneway Analysis of Log Pore Water Conc. By Pre- vs. Post-Treatment



Excluded Rows
88

Oneway Anova

Summary of Fit

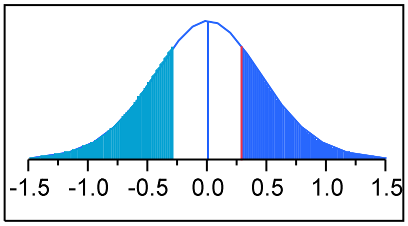
Rsquare	0.026364
Adj Rsquare	-0.04318
Root Mean Square Error	0.794711
Mean of Response	-4.00687
Observations (or Sum Wgts)	16

t Test

Pre-Treatment-Post-Treatment

Assuming equal variances

Difference	0.2825	t Ratio	0.615701
Std Err Dif	0.4588	DF	14
Upper CL Dif	1.2666	Prob > |t|	0.5480
Lower CL Dif	-0.7016	Prob > t	0.2740
Confidence	0.95	Prob < t	0.7260



Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Pre- vs. Post-Treatment	1	0.2394187	0.239419	0.3791	0.5480
Error	14	8.8419250	0.631566		
C. Total	15	9.0813438			

Means for Oneway Anova

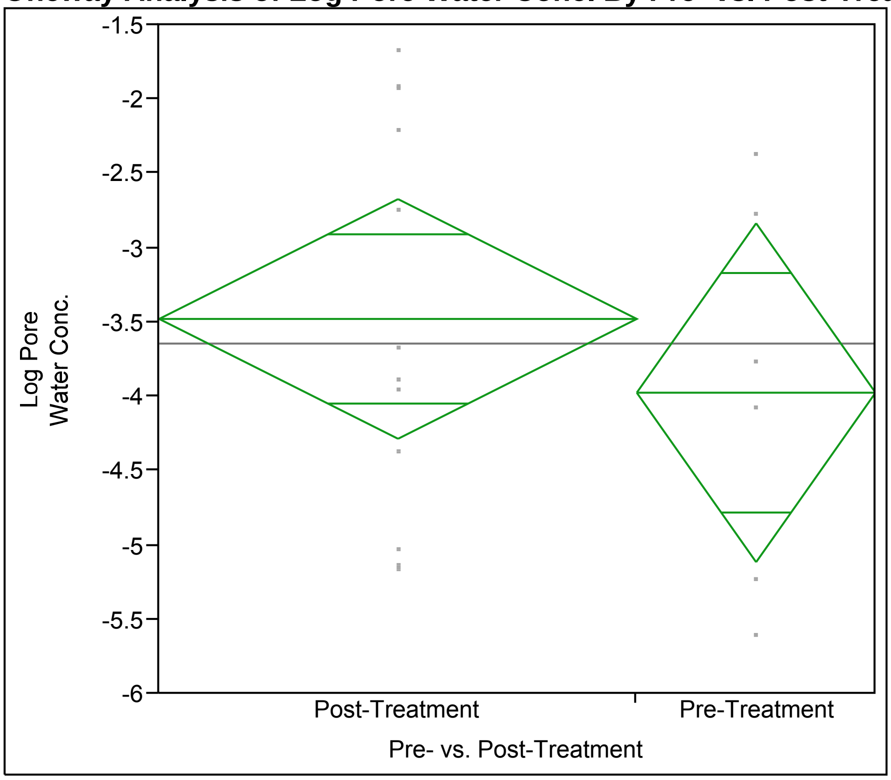
Level	Number	Mean	Std Error	Lower 95%	Upper 95%
Post-Treatment	12	-4.0775	0.22941	-4.570	-3.585
Pre-Treatment	4	-3.7950	0.39736	-4.647	-2.943

Std Error uses a pooled estimate of error variance

<u>ANOVA: Pore Water Concentration Evaluation between Pre- and Post-Treatment for *Sand Control*</u>

This ANOVA statistical analysis compared just the pore water concentrations data between pre- and post-treatment sampling periods within the Sand Control Plots. Analysis determined that the pre- and post-treatment pore water concentrations were **<u>not</u>** significantly different.

Oneway Analysis of Log Pore Water Conc. By Pre- vs. Post-Treatment



Excluded Rows
86

Oneway Anova
Summary of Fit

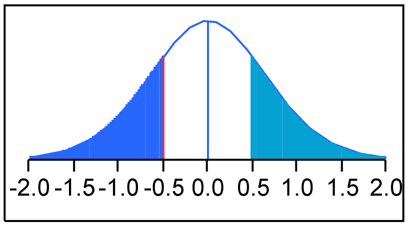
Rsquare	0.034315
Adj Rsquare	-0.02604
Root Mean Square Error	1.317384
Mean of Response	-3.64222
Observations (or Sum Wgts)	18

t Test
Pre-Treatment-Post-Treatment

Assuming equal variances

Difference	-0.4967	t Ratio	-0.75402
Std Err Dif	0.6587	DF	16
Upper CL Dif	0.8997	Prob > |t|	0.4618
Lower CL Dif	-1.8930	Prob > t	0.7691

Confidence	0.95	Prob < t	0.2309



Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Pre- vs. Post-Treatment	1	0.986711	0.98671	0.5685	0.4618
Error	16	27.768000	1.73550		
C. Total	17	28.754711			

Means for Oneway Anova

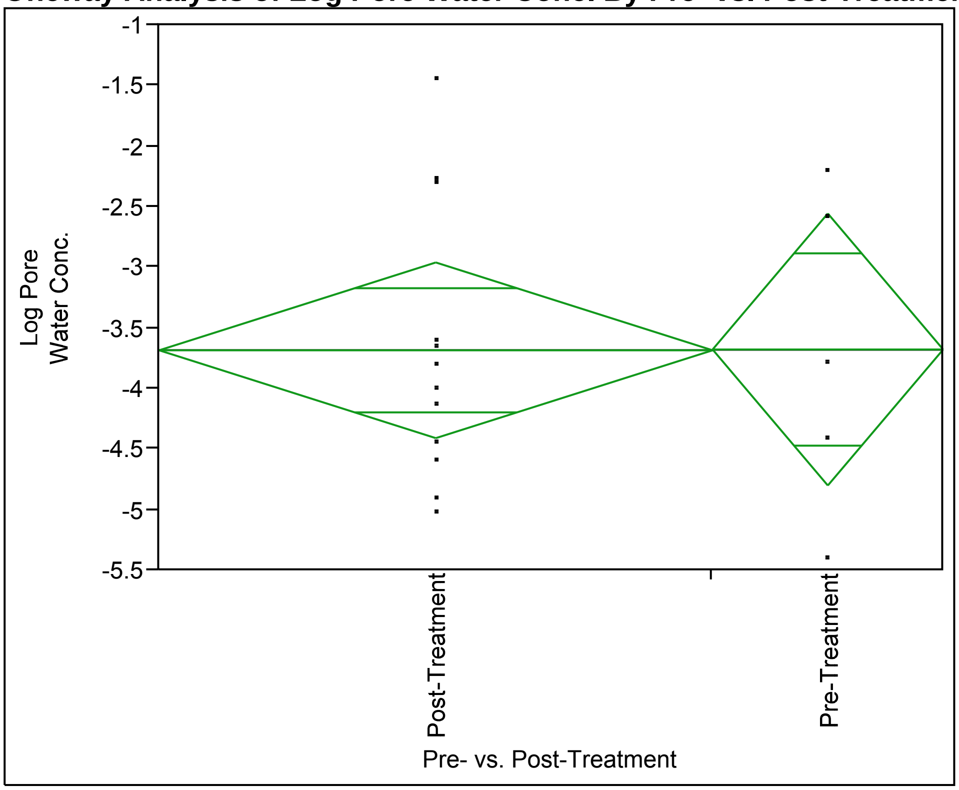
Level	Number	Mean	Std Error	Lower 95%	Upper 95%
Post-Treatment	12	-3.4767	0.38030	-4.283	-2.670
Pre-Treatment	6	-3.9733	0.53782	-5.113	-2.833

Std Error uses a pooled estimate of error variance

ANOVA: Pore Water Concentration Evaluation between Pre- and Post-Treatment for *Control*

This ANOVA statistical analysis compared just the pore water concentrations data between pre- and post-treatment sampling periods within the Control Plots. Analysis determined that the pre- and post-treatment pore water concentrations were **not** significantly different.

Oneway Analysis of Log Pore Water Conc. By Pre- vs. Post-Treatment



Excluded Rows
87

Oneway Anova
Summary of Fit

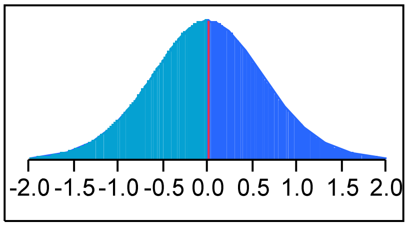
Rsquare	9.123e-6
Adj Rsquare	-0.06666
Root Mean Square Error	1.177709
Mean of Response	-3.68118
Observations (or Sum Wgts)	17

t Test
Pre-Treatment-Post-Treatment

Assuming equal variances

Difference	0.0073	t Ratio	0.011698
Std Err Dif	0.6269	DF	15
Upper CL Dif	1.3435	Prob > |t|	0.9908
Lower CL Dif	-1.3288	Prob > t	0.4954

Confidence 0.95 Prob < t 0.5046



Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Pre- vs. Post-Treatment	1	0.000190	0.00019	0.0001	0.9908
Error	15	20.804987	1.38700		
C. Total	16	20.805176			

Means for Oneway Anova

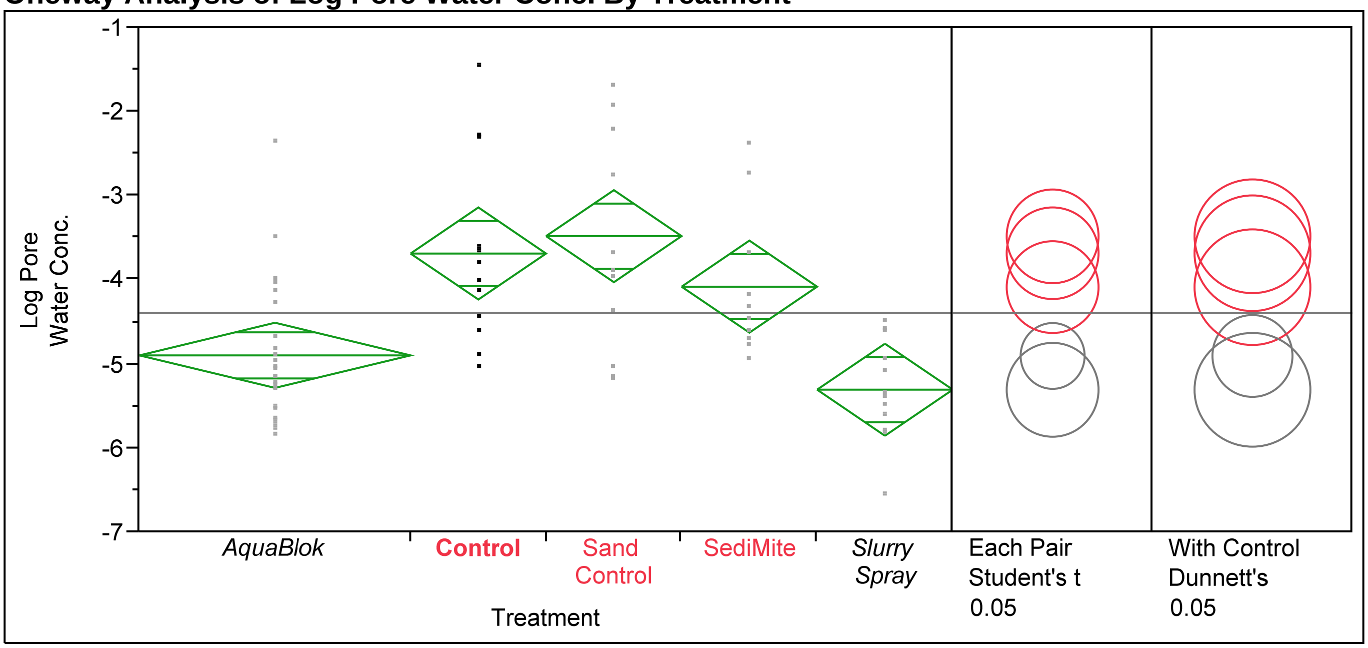
Level	Number	Mean	Std Error	Lower 95%	Upper 95%
Post-Treatment	12	-3.6833	0.33998	-4.408	-2.959
Pre-Treatment	5	-3.6760	0.52669	-4.799	-2.553

Std Error uses a pooled estimate of error variance

ANOVA: Post Treatment Pore Water Concentration evaluation of Various Treatments; Student's T Test: Determine Significance between Treatment Types; Control Dunnett's: Determine Significance between Control and All other Treatments

An ANOVA statistical analysis and Student's T means statistical comparison was conducted on all post-treatment pore water concentration data by "Treatment Type" (AquaBlok, Control, Sand Control, SediMite and Slurry Spray (AC)). ANOVA determined that Treatment Type was a significant variable within the data set (for PW conc). Student's T means statistical comparison determined that the AquaBlok and slurry spray were statistically separate from the Control. Dunnett's mean statistical comparison (with control set as the control) confirmed that AquaBlok and the AC slurry spray were both the different than the control.

Oneway Analysis of Log Pore Water Conc. By Treatment



Excluded Rows
32

Oneway Anova
Summary of Fit

Rsquare	0.354754
Adj Rsquare	0.316232
Root Mean Square Error	0.950716
Mean of Response	-4.38833
Observations (or Sum Wgts)	72

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Treatment	4	33.294979	8.32374	9.2091	<.0001*
Error	67	60.558621	0.90386		
C. Total	71	93.853600			

Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
AquaBlok	24	-4.8946	0.19406	-5.282	-4.507
Control	12	-3.6833	0.27445	-4.231	-3.136
Sand Control	12	-3.4767	0.27445	-4.024	-2.929
SediMite	12	-4.0775	0.27445	-4.625	-3.530
Slurry Spray	12	-5.3033	0.27445	-5.851	-4.756

Std Error uses a pooled estimate of error variance

Means Comparisons
Comparisons for each pair using Student's t
Confidence Quantile

t	Alpha
1.99601	0.05

LSD Threshold Matrix

Abs(Dif)-LSD	Sand Control	Control	SediMite	AquaBlok	Slurry Spray
Sand Control	-0.7747	-0.5680	-0.1739	0.7470	1.0520
Control	-0.5680	-0.7747	-0.3805	0.5403	0.8453
SediMite	-0.1739	-0.3805	-0.7747	0.1462	0.4511
AquaBlok	0.7470	0.5403	0.1462	-0.5478	-0.2622
Slurry Spray	1.0520	0.8453	0.4511	-0.2622	-0.7747

Positive values show pairs of means that are significantly different.

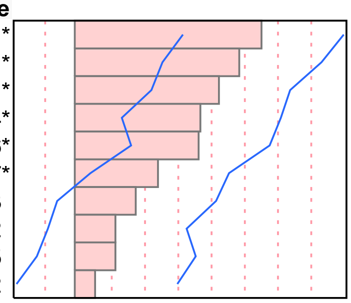
Connecting Letters Report

Level			Mean
Sand Control	A		-3.476667
Control	A		-3.683333
SediMite	A		-4.077500
AquaBlok		B	-4.894583
Slurry Spray		B	-5.303333

Levels not connected by same letter are significantly different.

Ordered Differences Report

Level	- Level	Difference	Std Err Dif	Lower CL	Upper CL	p-Value
Sand Control	Slurry Spray	1.826667	0.3881280	1.05196	2.601373	<.0001*
Control	Slurry Spray	1.620000	0.3881280	0.84529	2.394707	<.0001*
Sand Control	AquaBlok	1.417917	0.3361287	0.74700	2.088832	<.0001*
SediMite	Slurry Spray	1.225833	0.3881280	0.45113	2.000540	0.0024*
Control	AquaBlok	1.211250	0.3361287	0.54033	1.882166	0.0006*
SediMite	AquaBlok	0.817083	0.3361287	0.14617	1.487999	0.0177*
Sand Control	SediMite	0.600833	0.3881280	-0.17387	1.375540	0.1263
AquaBlok	Slurry Spray	0.408750	0.3361287	-0.26217	1.079666	0.2282
Control	SediMite	0.394167	0.3881280	-0.38054	1.168873	0.3135
Sand Control	Control	0.206667	0.3881280	-0.56804	0.981373	0.5962



Comparisons with a control using Dunnett's Method
Control Group =
Control

Confidence Quantile

|d|	Alpha
2.49015	0.05

LSD Threshold Matrix

Level	Abs(Dif)-LSD	p-Value
Sand Control	-0.76	0.9518
Control	-0.97	1.0000
SediMite	-0.57	0.6878
AquaBlok	0.374	0.0022*
Slurry Spray	0.654	0.0003*

Positive values show pairs of means that are significantly different.

Lumbriculus Receptor Tissue Concentration

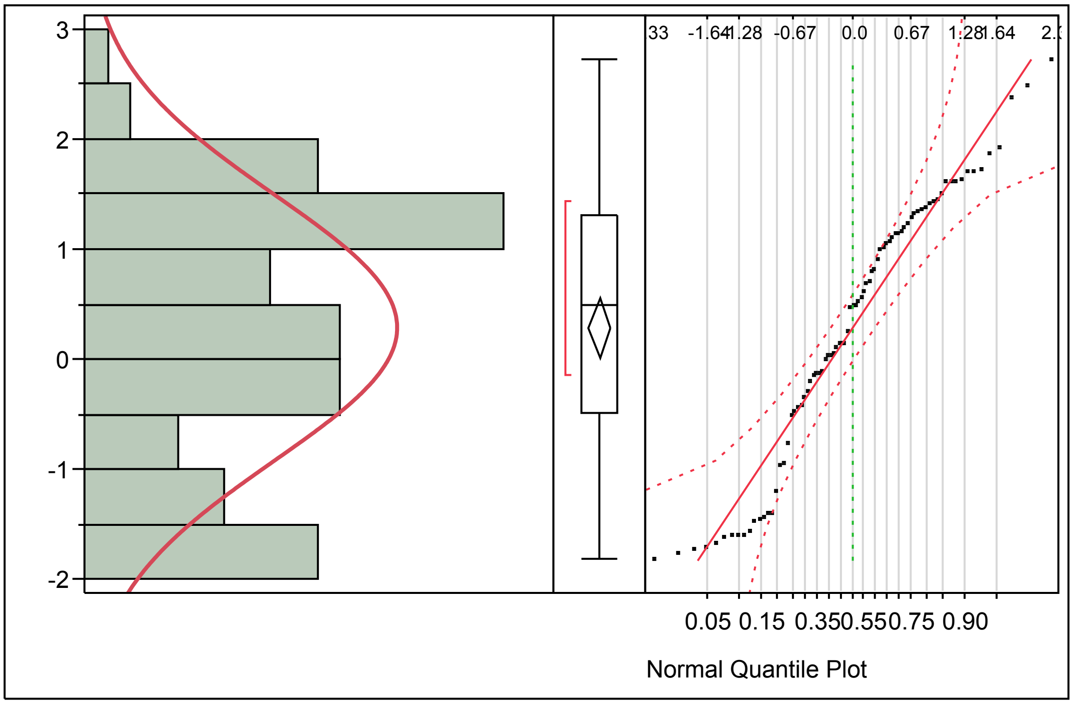
Statistical Evaluations

(all concentrations required logarithmic transformations)

Demonstration of Relative Normal Distribution for Log- Lumbriculus Receptor Tissue Concentration Data

The data is only weakly linearly distributed.

Distributions- Log - Lumbriculus Conc.



Normal(0.2951,1.20683)

Quantiles

100.0%	maximum	2.73
99.5%		2.73
97.5%		2.475
90.0%		1.688
75.0%	quartile	1.3
50.0%	median	0.49
25.0%	quartile	-0.489
10.0%		-1.6
2.5%		-1.758
0.5%		-1.82
0.0%	minimum	-1.82

Summary Statistics

Mean	0.2950952
Std Dev	1.206832
Std Err Mean	0.1340924
Upper 95% Mean	0.5619477
Lower 95% Mean	0.0282427
N	81

Fitted Normal

Parameter Estimates

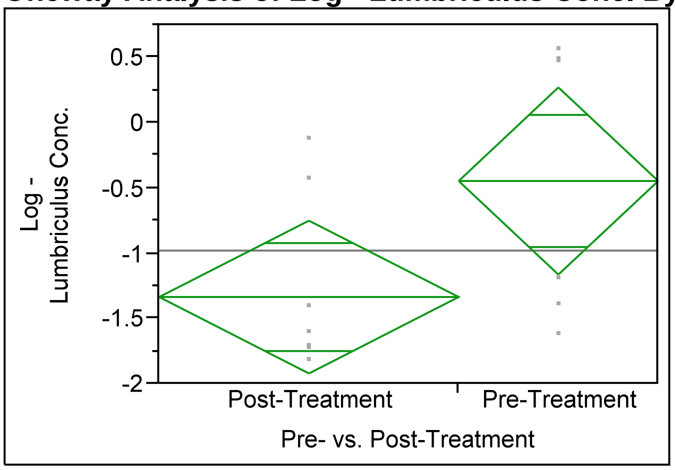
Type	Parameter	Estimate	Lower 95%	Upper 95%
Location	μ	0.2950952	0.0282427	0.5619477
Dispersion	σ	1.206832	1.0453339	1.427814

-2log(Likelihood) = 259.323838228505

<u>ANOVA: Lumbriculus Receptor Tissue Concentration Evaluation between Pre- and Post-Treatment for *AC Slurry Spray*</u>

This ANOVA statistical analysis compared Lumbriculus receptor tissue concentrations data from 28 day bioaccumulation studies between pre- and post-treatment sampling periods just within the Slurry Spray (AC Slurry) Plots. All data was logarithmically transformed for statistical analysis. Analysis determined that the pre- and post-treatment Lumbriculus tissue concentrations were **not** significantly different.

Oneway Analysis of Log - Lumbriculus Conc. By Pre- vs. Post-Treatment



Excluded Rows
66

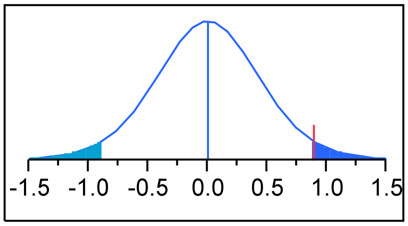
Oneway Anova
Summary of Fit

Rsquare	0.249053
Adj Rsquare	0.191288
Root Mean Square Error	0.813054
Mean of Response	-0.9782
Observations (or Sum Wgts)	15

t Test
Pre-Treatment-Post-Treatment

Assuming equal variances

Difference	0.8898	t Ratio	2.076411
Std Err Dif	0.4285	DF	13
Upper CL Dif	1.8155	Prob > |t|	0.0583
Lower CL Dif	-0.0360	Prob > t	0.0291*
Confidence	0.95	Prob < t	0.9709



Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Pre- vs. Post-Treatment	1	2.850136	2.85014	4.3115	0.0583
Error	13	8.593738	0.66106		
C. Total	14	11.443874			

Means for Oneway Anova

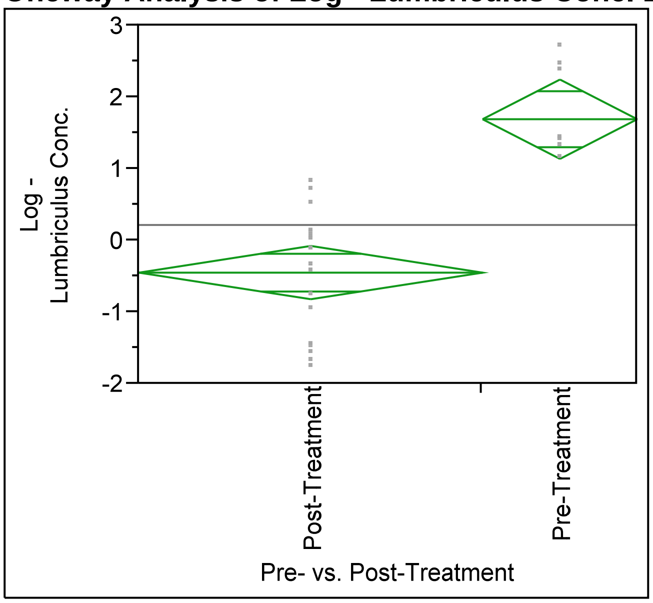
Level	Number	Mean	Std Error	Lower 95%	Upper 95%
Post-Treatment	9	-1.3341	0.27102	-1.920	-0.7486
Pre-Treatment	6	-0.4443	0.33193	-1.161	0.2728

Std Error uses a pooled estimate of error variance

ANOVA: Lumbriculus Receptor Tissue Concentration Evaluation between Pre- and Post-Treatment for *AquaBlok*

This ANOVA statistical analysis compared Lumbriculus receptor tissue concentrations data from 28 day bioaccumulation studies between pre- and post-treatment sampling periods just within the AquaBlok Plots. All data was logarithmically transformed for statistical analysis. Analysis determined that the pre- and post-treatment Lumbriculus tissue concentrations were significantly different.

Oneway Analysis of Log - Lumbriculus Conc. By Pre- vs. Post-Treatment



Excluded Rows
52

Oneway Anova

Summary of Fit

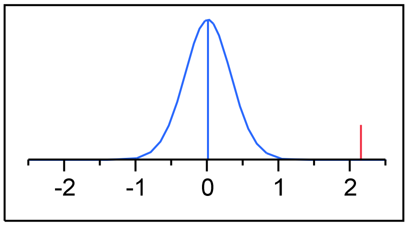
Rsquare	0.616253
Adj Rsquare	0.60204
Root Mean Square Error	0.810354
Mean of Response	0.217348
Observations (or Sum Wgts)	29

t Test

Pre-Treatment-Post-Treatment

Assuming equal variances

Difference	2.14179	t Ratio	6.584746
Std Err Dif	0.32527	DF	27
Upper CL Dif	2.80918	Prob > |t|	<.0001*
Lower CL Dif	1.47440	Prob > t	<.0001*
Confidence	0.95	Prob < t	1.0000



Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Pre- vs. Post-Treatment	1	28.472661	28.4727	43.3589	<.0001*
Error	27	17.730205	0.6567		
C. Total	28	46.202866			

Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
Post-Treatment	20	-0.4473	0.18120	-0.819	-0.076
Pre-Treatment	9	1.6944	0.27012	1.140	2.249

Std Error uses a pooled estimate of error variance

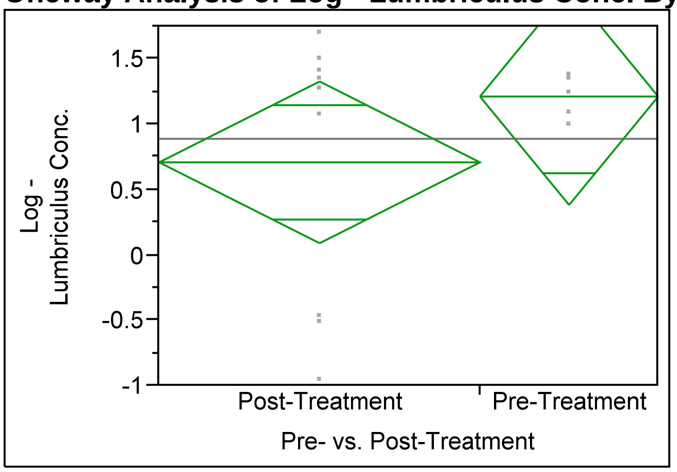
ANOVA: Lumbriculus Receptor Tissue Concentration Evaluation between Pre- and Post-Treatment for *SediMite*

Hydric soil samples were not collected from SediMite plots for Lumbriculus receptor 28-day bioaccumulation studies. Therefore, statistical analysis was not conducted for this treatment type and no data are available.

ANOVA: Lumbriculus Receptor Tissue Concentration Evaluation between Pre- and Post-Treatment for *Sand Control*

This ANOVA statistical analysis compared Lumbriculus receptor tissue concentrations data from 28 day bioaccumulation studies between pre- and post-treatment sampling periods just within the Sand Control Plots. All data was logarithmically transformed for statistical analysis. Analysis determined that the pre- and post-treatment Lumbriculus tissue concentrations were **not** significantly different.

Oneway Analysis of Log - Lumbriculus Conc. By Pre- vs. Post-Treatment



Excluded Rows
67

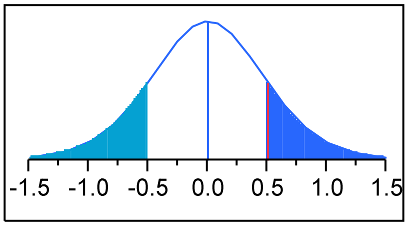
Oneway Anova
Summary of Fit

Rsquare	0.08584
Adj Rsquare	0.00966
Root Mean Square Error	0.852924
Mean of Response	0.891357
Observations (or Sum Wgts)	14

t Test
Pre-Treatment-Post-Treatment

Assuming equal variances

Difference	0.5050	t Ratio	1.061508
Std Err Dif	0.4757	DF	12
Upper CL Dif	1.5415	Prob > |t|	0.3094
Lower CL Dif	-0.5315	Prob > t	0.1547
Confidence	0.95	Prob < t	0.8453



Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Pre- vs. Post-Treatment	1	0.8197232	0.819723	1.1268	0.3094
Error	12	8.7297500	0.727479		
C. Total	13	9.5494732			

Means for Oneway Anova

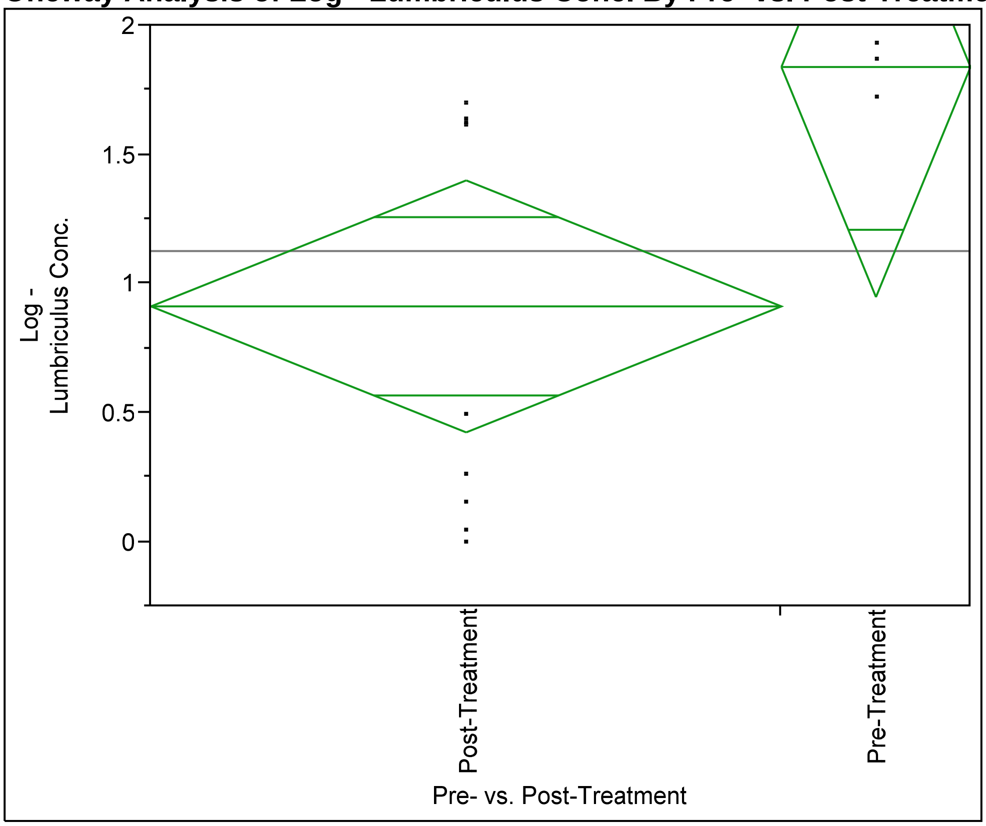
Level	Number	Mean	Std Error	Lower 95%	Upper 95%
Post-Treatment	9	0.71100	0.28431	0.09155	1.3305
Pre-Treatment	5	1.21600	0.38144	0.38492	2.0471

Std Error uses a pooled estimate of error variance

<u>ANOVA: Lumbriculus Receptor Tissue Concentration Evaluation between Pre- and Post-Treatment for *Control*</u>

This ANOVA statistical analysis compared Lumbriculus receptor tissue concentrations data from 28 day bioaccumulation studies between pre- and post-treatment sampling periods just within the Control Plots. All data was logarithmically transformed for statistical analysis. Analysis determined that the pre- and post-treatment Lumbriculus tissue concentrations were **<u>not</u>** significantly different.

Oneway Analysis of Log - Lumbriculus Conc. By Pre- vs. Post-Treatment



Excluded Rows
68

Oneway Anova

Summary of Fit

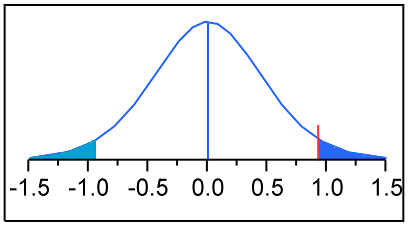
Rsquare	0.268174
Adj Rsquare	0.201645
Root Mean Square Error	0.701584
Mean of Response	1.126739
Observations (or Sum Wgts)	13

t Test

Pre-Treatment-Post-Treatment

Assuming equal variances

Difference	0.9272	t Ratio	2.007711
Std Err Dif	0.4618	DF	11
Upper CL Dif	1.9437	Prob > |t|	0.0699
Lower CL Dif	-0.0893	Prob > t	0.0349*
Confidence	0.95	Prob < t	0.9651



Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Pre- vs. Post-Treatment	1	1.9840896	1.98409	4.0309	0.0699
Error	11	5.4144174	0.49222		
C. Total	12	7.3985070			

Means for Oneway Anova

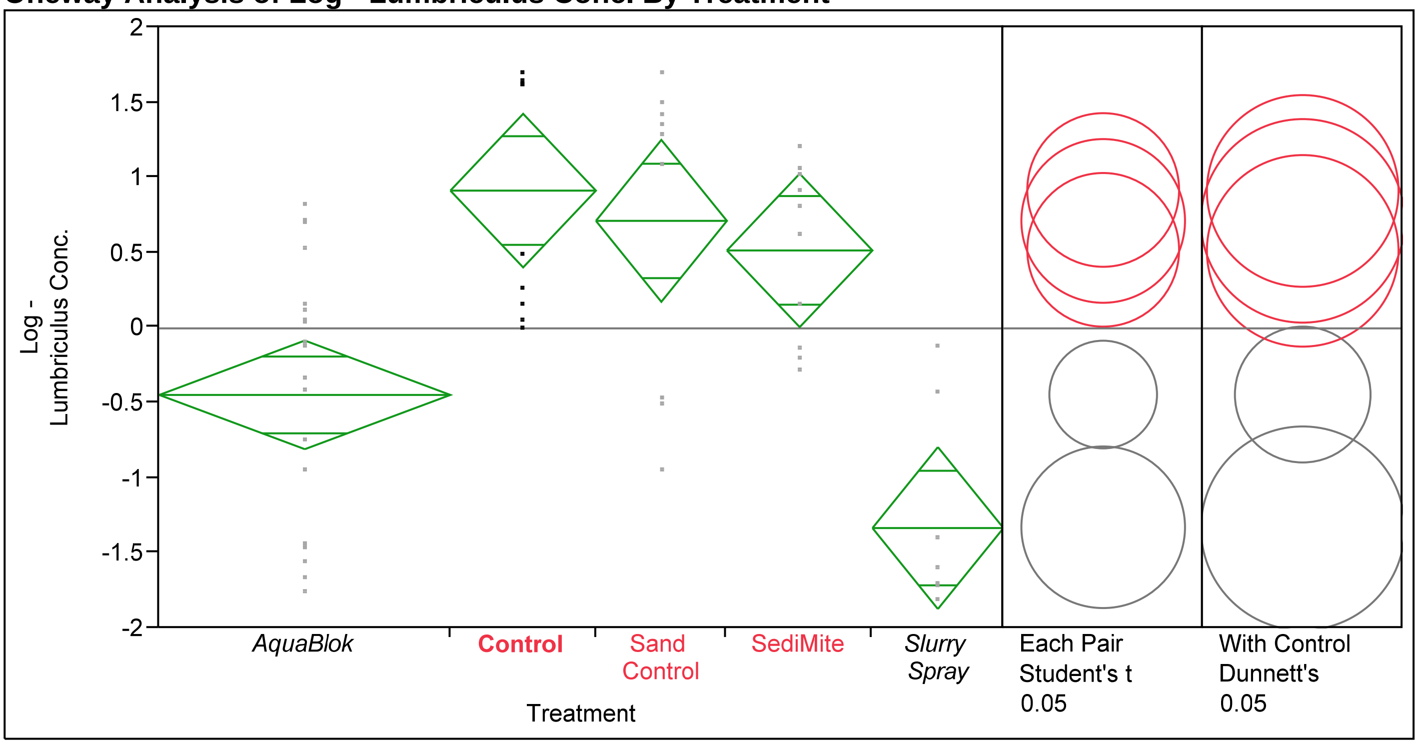
Level	Number	Mean	Std Error	Lower 95%	Upper 95%
Post-Treatment	10	0.91276	0.22186	0.42445	1.4011
Pre-Treatment	3	1.84000	0.40506	0.94847	2.7315

Std Error uses a pooled estimate of error variance

ANOVA: Post Treatment Lumbriculus Receptor Tissue Concentration evaluation of Various Treatments; Student's T Test: Determine Significance between Treatment Types; Control Dunnett's: Determine Significance between Control and All other Treatments

An ANOVA statistical analysis and Student's T means statistical comparison was conducted on all post-treatment Lumbriculus receptor tissue concentration data collected from 28-day bioaccumulation studies by "Treatment Type" (AquaBlok, Control, Sand Control, SediMite and Slurry Spray (AC)). ANOVA determined that Treatment Type was a significant variable within the data set (for PW conc). Student's T means statistical comparison determined that the AquaBlok and slurry spray were statistically separate from the Control. Dunnett's mean statistical comparison (with control set as the control) confirmed that AquaBlok and the AC slurry spray were both different than the control.

Oneway Analysis of Log - Lumbriculus Conc. By Treatment



Excluded Rows
23

Oneway Anova

Summary of Fit

Rsquare	0.508009
Adj Rsquare	0.470878
Root Mean Square Error	0.805967
Mean of Response	-0.00485
Observations (or Sum Wgts)	58

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Treatment	4	35.548806	8.88720	13.6814	<.0001*
Error	53	34.427908	0.64958		
C. Total	57	69.976713			

Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
AquaBlok	20	-0.4473	0.18022	-0.809	-0.086
Control	10	0.9128	0.25487	0.402	1.424
Sand Control	9	0.7110	0.26866	0.172	1.250
SediMite	10	0.5146	0.25487	0.0034	1.026
Slurry Spray	9	-1.3341	0.26866	-1.873	-0.795

Std Error uses a pooled estimate of error variance

Means Comparisons
Comparisons for each pair using Student's t
Confidence Quantile

t	Alpha
2.00575	0.05

LSD Threshold Matrix

Abs(Dif)-LSD	Control	Sand Control	SediMite	AquaBlok	Slurry Spray
Control	-0.7230	-0.5410	-0.3248	0.7340	1.5041
Sand Control	-0.5410	-0.7621	-0.5464	0.5095	1.2831
SediMite	-0.3248	-0.5464	-0.7230	0.3359	1.1060
AquaBlok	0.7340	0.5095	0.3359	-0.5112	0.2379
Slurry Spray	1.5041	1.2831	1.1060	0.2379	-0.7621

Positive values show pairs of means that are significantly different.

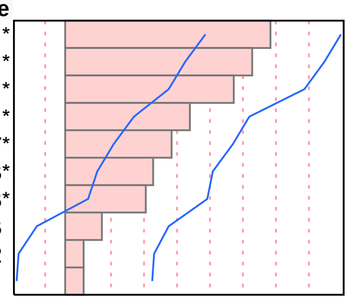
Connecting Letters Report

Level				Mean
Control	A			0.912761
Sand Control	A			0.711000
SediMite	A			0.514600
AquaBlok		B		-0.447345
Slurry Spray			C	-1.334111

Levels not connected by same letter are significantly different.

Ordered Differences Report

Level	- Level	Difference	Std Err Dif	Lower CL	Upper CL	p-Value
Control	Slurry Spray	2.246872	0.3703164	1.50411	2.989633	<.0001*
Sand Control	Slurry Spray	2.045111	0.3799366	1.28305	2.807167	<.0001*
SediMite	Slurry Spray	1.848711	0.3703164	1.10595	2.591472	<.0001*
Control	AquaBlok	1.360106	0.3121498	0.73401	1.986199	<.0001*
Sand Control	AquaBlok	1.158345	0.3235044	0.50948	1.807213	0.0007*
SediMite	AquaBlok	0.961945	0.3121498	0.33585	1.588038	0.0033*
AquaBlok	Slurry Spray	0.886766	0.3235044	0.23790	1.535634	0.0083*
Control	SediMite	0.398161	0.3604395	-0.32479	1.121111	0.2743
Control	Sand Control	0.201761	0.3703164	-0.54100	0.944522	0.5882
Sand Control	SediMite	0.196400	0.3703164	-0.54636	0.939161	0.5981



Comparisons with a control using Dunnett's Method
Control Group =

Control

Confidence Quantile

|d|	Alpha
2.50986	0.05

LSD Threshold Matrix

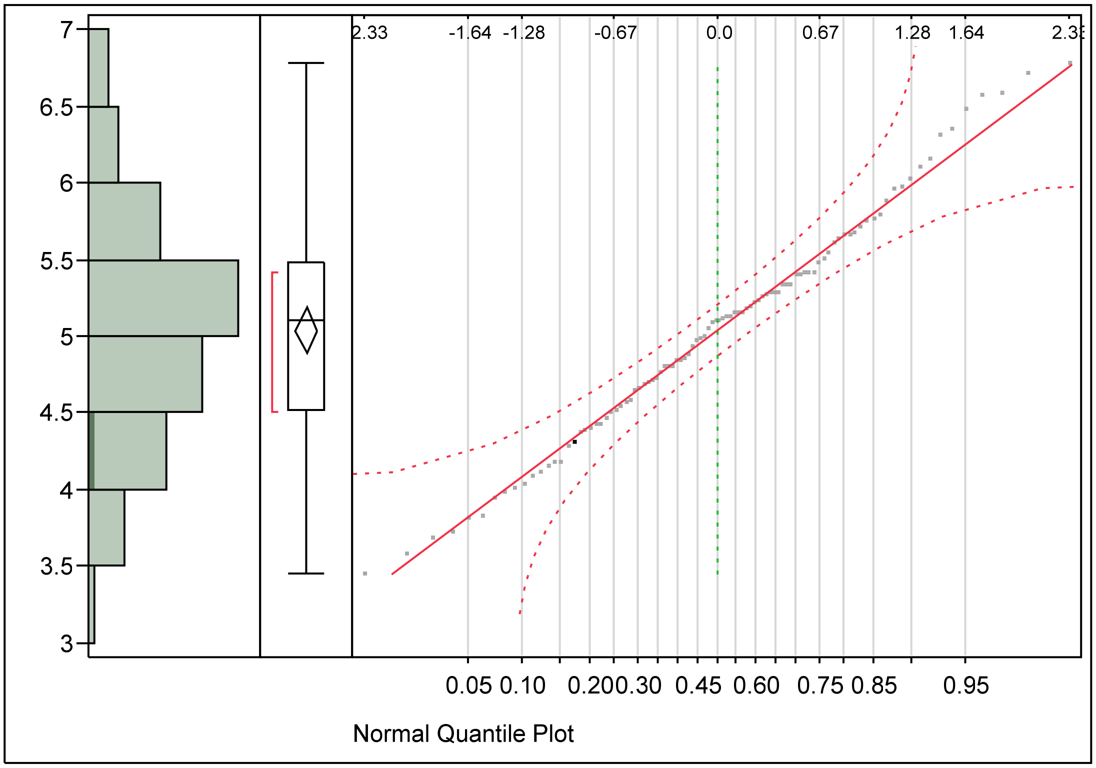
Level	Abs(Dif)-LSD	p-Value
Control	-0.9	1.0000
Sand Control	-0.73	0.9491
SediMite	-0.51	0.6302
AquaBlok	0.577	0.0002*
Slurry Spray	1.317	<.0001*

Positive values show pairs of means that are significantly different.

Pore Water to Bulk Solid Phase Partitioning Coefficient Statistical Evaluations

Demonstration of Relative Normal Distribution for Log $K_{bulk/PW}$ Data

Distributions Log-K(bulk/pw)



Quantiles

100.0%	maximum	6.78
99.5%		6.78
97.5%		6.65825
90.0%		6.038
75.0%	quartile	5.4875
50.0%	median	5.1
25.0%	quartile	4.5175
10.0%		4.037
2.5%		3.6275
0.5%		3.45
0.0%	minimum	3.45

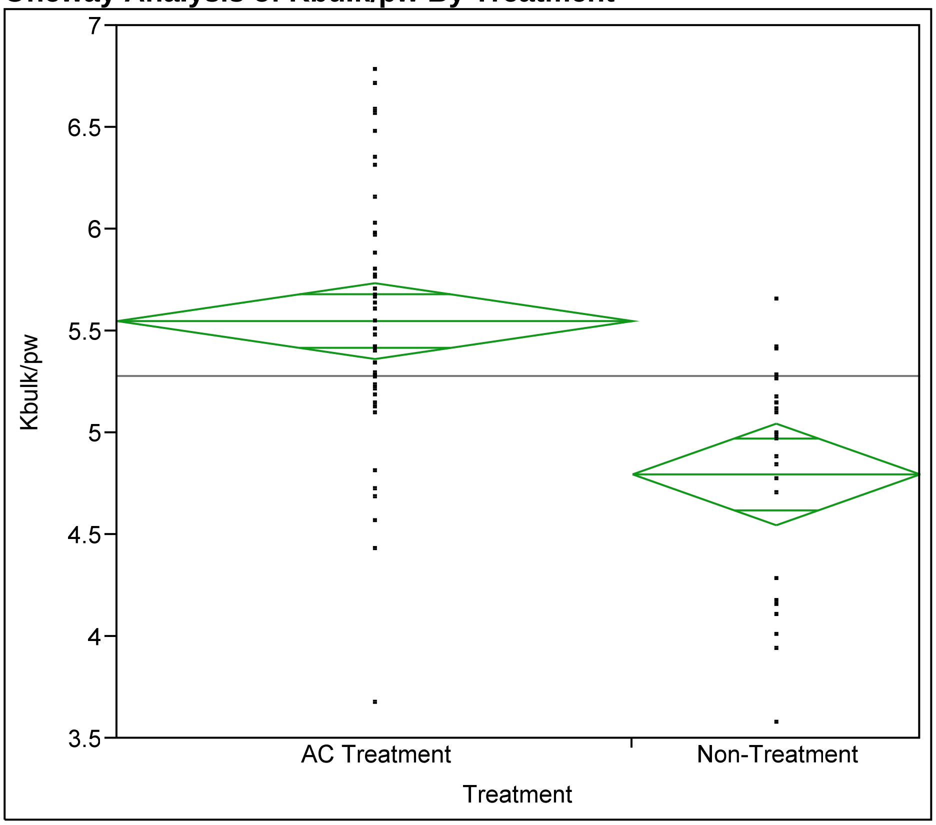
Summary Statistics

Mean	5.0452041
Std Dev	0.7416355
Std Err Mean	0.0749165
Upper 95% Mean	5.1938926
Lower 95% Mean	4.8965156
N	98

Post-Treatment $K_{bulk/pw}$ evaluation of Treated vs. Non-Treated Test Plots

This ANOVA statistical analysis compared all post-treatment $K_{bulk/pw}$ data by whether the treatment plots contained an Activated Carbon Amendment (AC Slurry, AquaBlok or SediMite) or were control plots. Analysis determined that the two data sets were significantly different.

Oneway Analysis of Kbulk/pw By Treatment



Oneway Anova
Summary of Fit

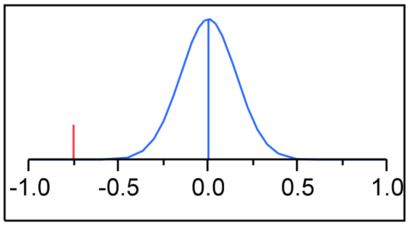
Rsquare	0.26426
Adj Rsquare	0.252941
Root Mean Square Error	0.611827
Mean of Response	5.281343
Observations (or Sum Wgts)	67

t Test
Non-Treatment-AC Treatment

Assuming equal variances

Difference	-0.7532	t Ratio	-4.83182
Std Err Dif	0.1559	DF	65
Upper CL Dif	-0.4419	Prob > |t|	<.0001*
Lower CL Dif	-1.0646	Prob > t	1.0000

Confidence	0.95	Prob < t	<.0001*



Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Treatment	1	8.739341	8.73934	23.3464	<.0001*
Error	65	24.331638	0.37433		
C. Total	66	33.070979			

Means for Oneway Anova

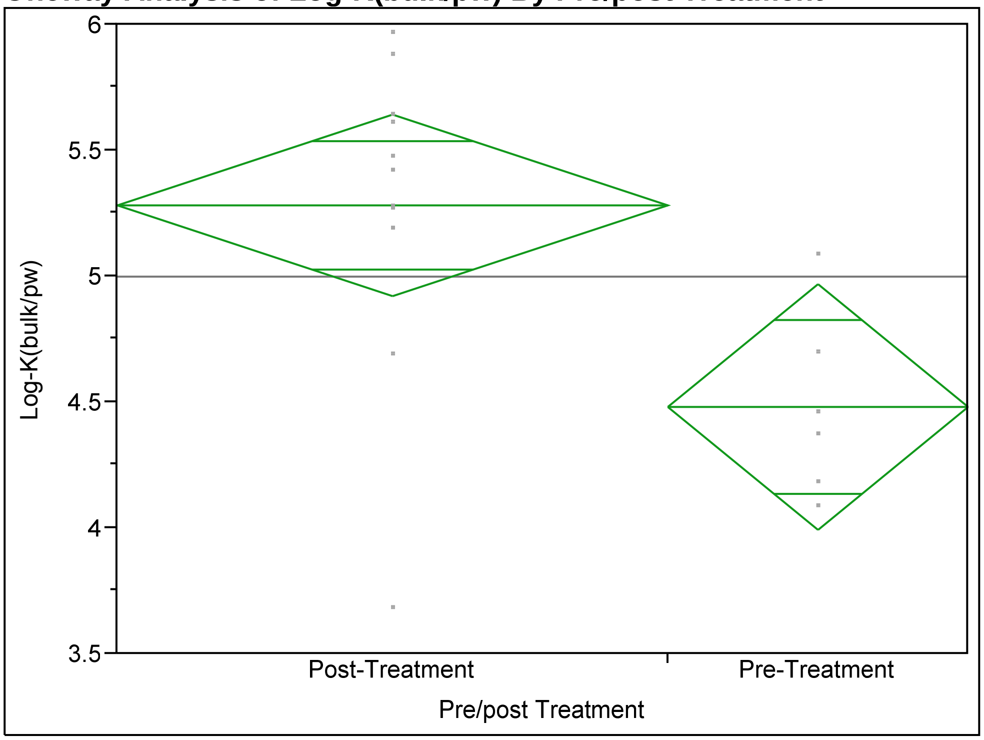
Level	Number	Mean	Std Error	Lower 95%	Upper 95%
AC Treatment	43	5.55116	0.09330	5.3648	5.7375
Non-Treatment	24	4.79792	0.12489	4.5485	5.0473

Std Error uses a pooled estimate of error variance

ANOVA: $K_{bulk/pw}$ Evaluation between Pre- and Post-Treatment for *AC Slurry Spray*

This ANOVA statistical analysis compared just AC Slurry (Slurry Spray) $K_{bulk/pw}$ data between pre- and post-treatment sampling periods. Analysis determined that the pre- and post-treatment $K_{bulk/pw}$ values were significantly different.

Oneway Analysis of Log-K(bulk/pw) By Pre/post Treatment



Excluded Rows
81

Oneway Anova

Summary of Fit

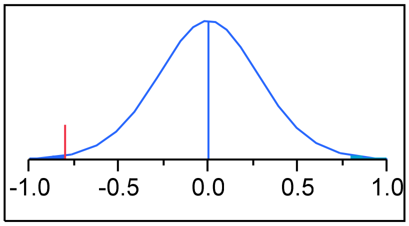
Rsquare	0.345208
Adj Rsquare	0.301555
Root Mean Square Error	0.561278
Mean of Response	5
Observations (or Sum Wgts)	17

t Test

Pre-Treatment-Post-Treatment

Assuming equal variances

Difference	-0.8011	t Ratio	-2.81212
Std Err Dif	0.2849	DF	15
Upper CL Dif	-0.1939	Prob > |t|	0.0131*
Lower CL Dif	-1.4082	Prob > t	0.9934
Confidence	0.95	Prob < t	0.0066*



Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Pre/post Treatment	1	2.4912985	2.49130	7.9080	0.0131*
Error	15	4.7255015	0.31503		
C. Total	16	7.2168000			

Means for Oneway Anova

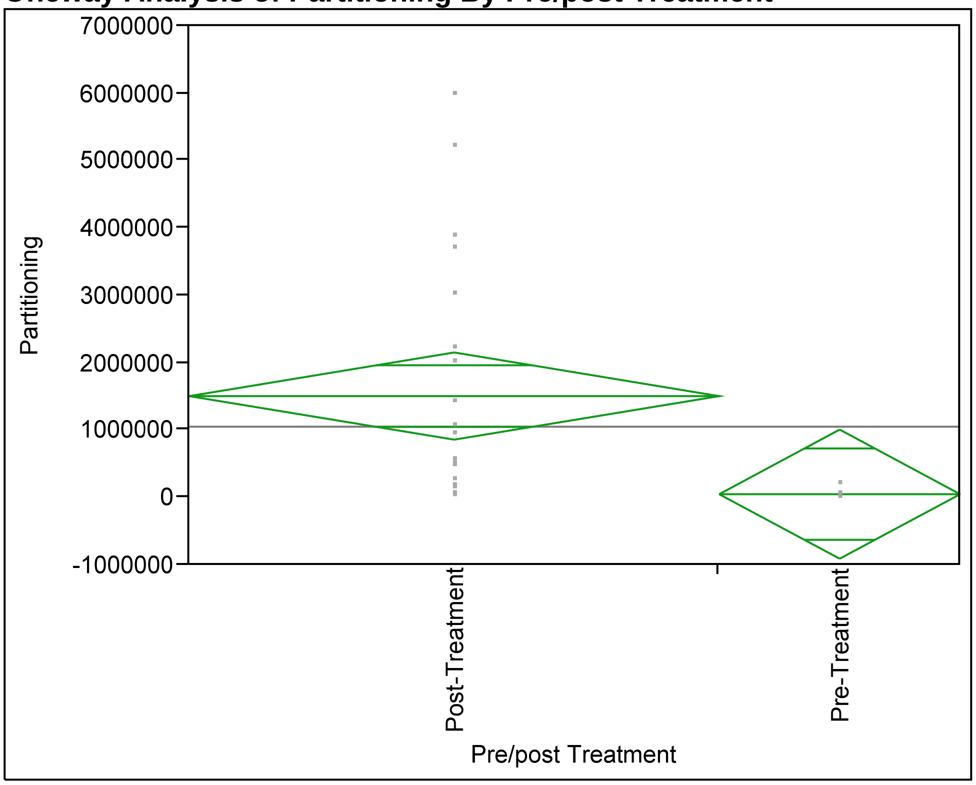
Level	Number	Mean	Std Error	Lower 95%	Upper 95%
Post-Treatment	11	5.28273	0.16923	4.9220	5.6434
Pre-Treatment	6	4.48167	0.22914	3.9933	4.9701

Std Error uses a pooled estimate of error variance

<u>ANOVA: $K_{bulk/pw}$ Evaluation between Pre- and Post-Treatment for *AquaBlok*</u>

This ANOVA statistical analysis compared just AquaBlok $K_{bulk/pw}$ data between pre- and post-treatment sampling periods. Analysis determined that the pre- and post-treatment $K_{bulk/pw}$ values were significantly different.

Oneway Analysis of Partitioning By Pre/post Treatment



Excluded Rows
66

Oneway Anova

Summary of Fit

Rsquare	0.180533
Adj Rsquare	0.153217
Root Mean Square Error	1484602
Mean of Response	1052775
Observations (or Sum Wgts)	32

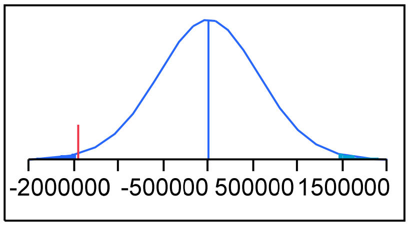
t Test

Pre-Treatment-Post-Treatment

Assuming equal variances

Difference	-1455615	t Ratio	-2.57083
Std Err Dif	566205	DF	30
Upper CL Dif	-299270	Prob > |t|	0.0153*
Lower CL Dif	-2611959	Prob > t	0.9923

Confidence	0.95	Prob < t	0.0077*



Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Pre/post Treatment	1	1.4567e+13	1.457e+13	6.6091	0.0153*
Error	30	6.6121e+13	2.204e+12		
C. Total	31	8.0688e+13			

Means for Oneway Anova

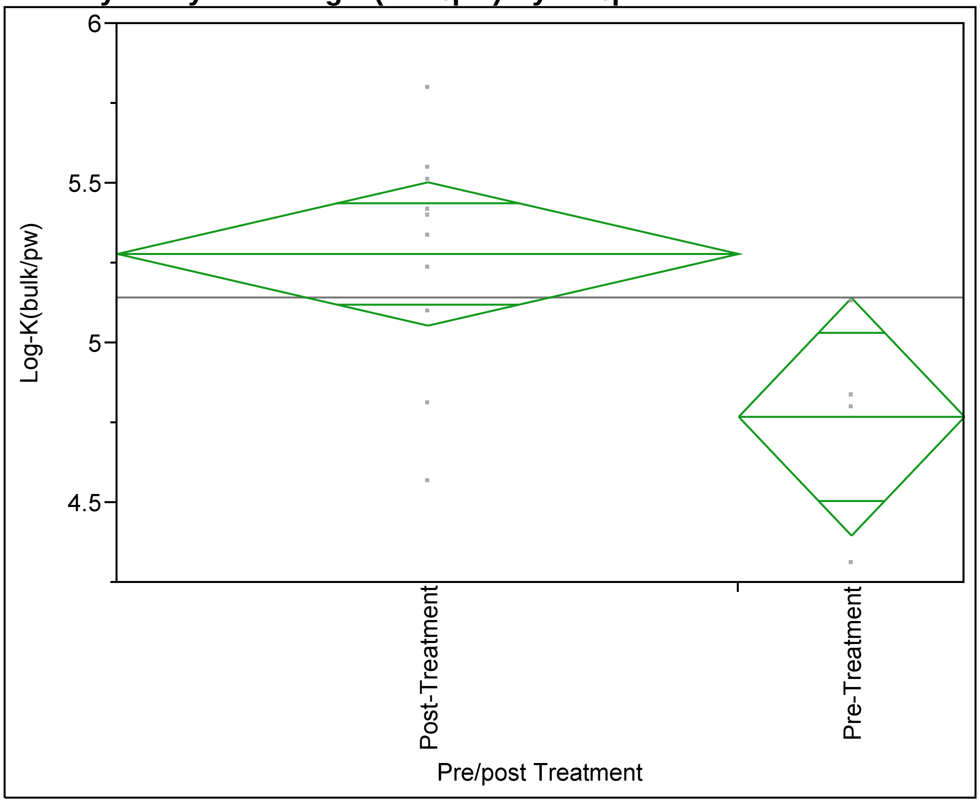
Level	Number	Mean	Std Error	Lower 95%	Upper 95%
Post-Treatment	22	1507655	316518	861238	2154070.8
Pre-Treatment	10	52040	469472	-906750	1010830.3

Std Error uses a pooled estimate of error variance

ANOVA: $K_{bulk/pw}$ Evaluation between Pre- and Post-Treatment for *SediMite*

This ANOVA statistical analysis compared just SediMite $K_{bulk/pw}$ data between pre- and post-treatment sampling periods. Analysis determined that the pre- and post-treatment $K_{bulk/pw}$ values were significantly different.

Oneway Analysis of Log-K(bulk/pw) By Pre/post Treatment



Excluded Rows
83

Oneway Anova
Summary of Fit

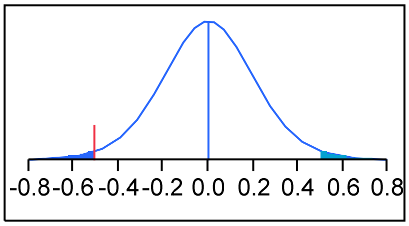
Rsquare	0.330807
Adj Rsquare	0.279331
Root Mean Square Error	0.344562
Mean of Response	5.144
Observations (or Sum Wgts)	15

t Test
Pre-Treatment-Post-Treatment

Assuming equal variances

Difference	-0.51000	t Ratio	-2.53503
Std Err Dif	0.20118	DF	13
Upper CL Dif	-0.07537	Prob > |t|	0.0249*
Lower CL Dif	-0.94463	Prob > t	0.9876

Confidence	0.95	Prob < t	0.0124*



Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Pre/post Treatment	1	0.7629600	0.762960	6.4264	0.0249*
Error	13	1.5434000	0.118723		
C. Total	14	2.3063600			

Means for Oneway Anova

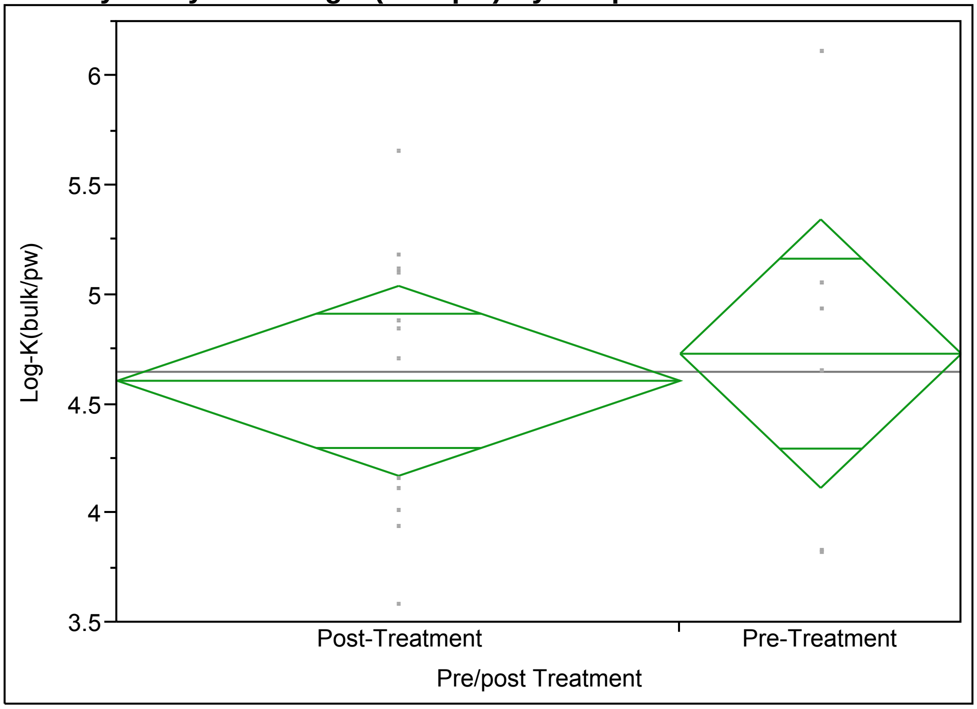
Level	Number	Mean	Std Error	Lower 95%	Upper 95%
Post-Treatment	11	5.28000	0.10389	5.0556	5.5044
Pre-Treatment	4	4.77000	0.17228	4.3978	5.1422

Std Error uses a pooled estimate of error variance

ANOVA: $K_{bulk/pw}$ Evaluation between Pre- and Post-Treatment for *Sand Control*

This ANOVA statistical analysis compared just Sand Control $K_{bulk/pw}$ data between pre- and post-treatment sampling periods. Analysis determined that the pre- and post-treatment $K_{bulk/pw}$ values were not significantly different.

Oneway Analysis of Log-K(bulk/pw) By Pre/post Treatment



Excluded Rows
80

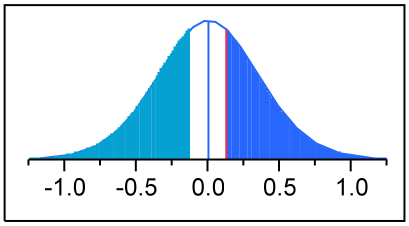
Oneway Anova
Summary of Fit

Rsquare	0.007577
Adj Rsquare	-0.05445
Root Mean Square Error	0.710498
Mean of Response	4.648889
Observations (or Sum Wgts)	18

t Test
Pre-Treatment-Post-Treatment

Assuming equal variances

Difference	0.12417	t Ratio	0.34952
Std Err Dif	0.35525	DF	16
Upper CL Dif	0.87726	Prob > |t|	0.7313
Lower CL Dif	-0.62893	Prob > t	0.3656
Confidence	0.95	Prob < t	0.6344



Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Pre/post Treatment	1	0.0616694	0.061669	0.1222	0.7313
Error	16	8.0769083	0.504807		
C. Total	17	8.1385778			

Means for Oneway Anova

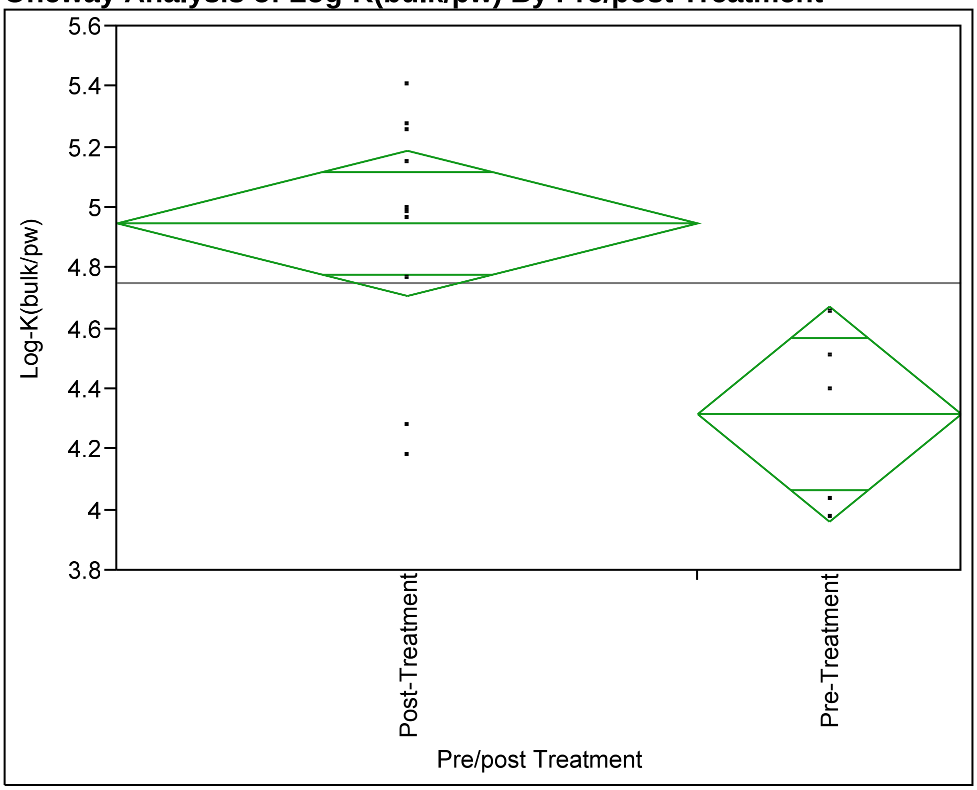
Level	Number	Mean	Std Error	Lower 95%	Upper 95%
Post-Treatment	12	4.60750	0.20510	4.1727	5.0423
Pre-Treatment	6	4.73167	0.29006	4.1168	5.3466

Std Error uses a pooled estimate of error variance

ANOVA: $K_{bulk/pw}$ Evaluation between Pre- and Post-Treatment for *Control*

This ANOVA statistical analysis compared just Control (no treatment) $K_{bulk/pw}$ data between pre- and post-treatment sampling periods. Analysis determined that the pre- and post-treatment $K_{bulk/pw}$ values were significantly different.

Oneway Analysis of Log-K(bulk/pw) By Pre/post Treatment



Excluded Rows
82

Oneway Anova

Summary of Fit

Rsquare	0.415318
Adj Rsquare	0.373555
Root Mean Square Error	0.371038
Mean of Response	4.751875
Observations (or Sum Wgts)	16

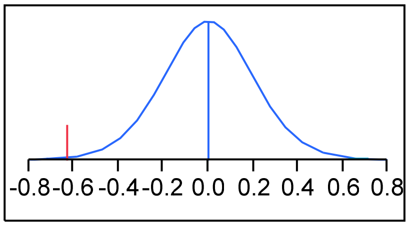
t Test

Pre-Treatment-Post-Treatment

Assuming equal variances

Difference	-0.6311	t Ratio	-3.15351
Std Err Dif	0.2001	DF	14
Upper CL Dif	-0.2019	Prob > |t|	0.0070*

Lower CL Dif	-1.0603	Prob > t	0.9965
Confidence	0.95	Prob < t	0.0035*



Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Pre/post Treatment	1	1.3690728	1.36907	9.9446	0.0070*
Error	14	1.9273709	0.13767		
C. Total	15	3.2964438			

Means for Oneway Anova

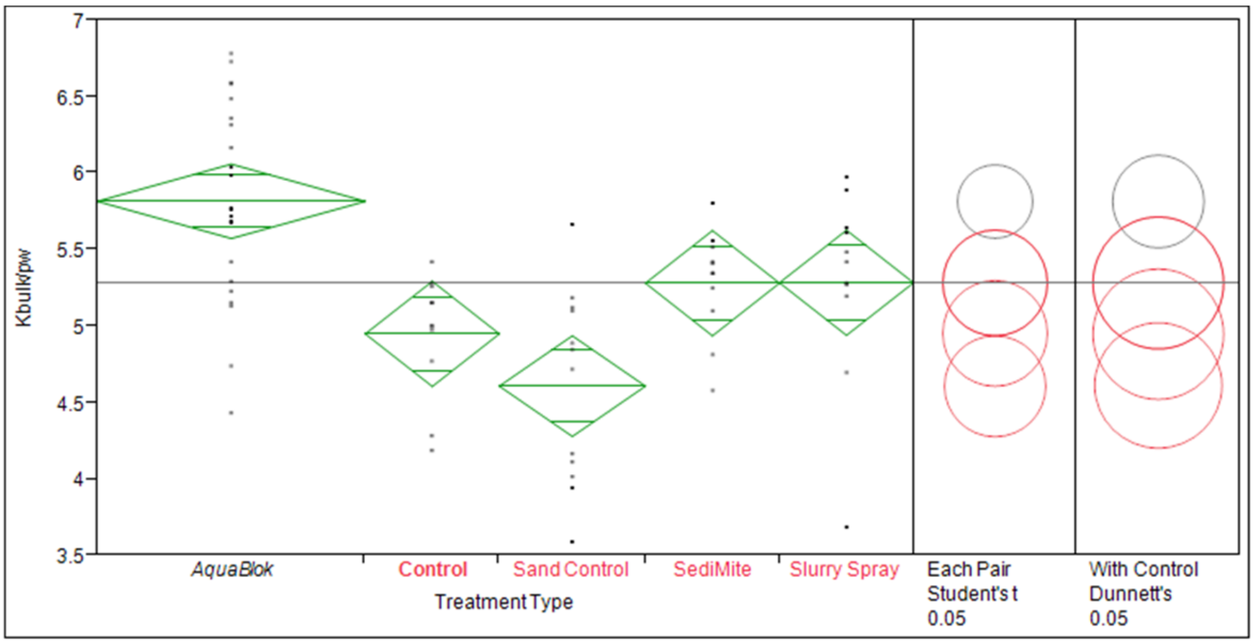
Level	Number	Mean	Std Error	Lower 95%	Upper 95%
Post-Treatment	11	4.94909	0.11187	4.7091	5.1890
Pre-Treatment	5	4.31800	0.16593	3.9621	4.6739

Std Error uses a pooled estimate of error variance

ANOVA: Post Treatment $K_{bulk/pw}$ evaluation of Different Treatments; Student's T Test: Determine Significance between Treatment Types; Control Dunnett's: Determine Significance between Control and All other Treatments

An ANOVA statistical analysis and Student's T means statistical comparison was conducted on all post-treatment $K_{bulk/pw}$ data by "Treatment Type" (AquaBlok, Control, Sand Control, SediMite and Slurry Spray (AC)). ANOVA determined that Treatment Type was a significant variable within the data set (for $K_{bulk/pw}$). Student's T means statistical comparison determined that the AquaBlok was statistically separate from the Control. Dunnett's mean statistical comparison (with control set as the control) confirmed that AquaBlok was the only Treatment different than the control.

Oneway Analysis of Kbulk/pw By Treatment Type



Oneway Anova
Summary of Fit

Rsquare	0.390932
Adj Rsquare	0.351637
Root Mean Square Error	0.569981
Mean of Response	5.281343
Observations (or Sum Wgts)	67

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Treatment Type	4	12.928495	3.23212	9.9487	<.0001*
Error	62	20.142484	0.32488		
C. Total	66	33.070979			

Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
AquaBlok	22	5.81500	0.12152	5.5721	6.0579
Control	11	4.94909	0.17186	4.6056	5.2926
Sand Control	12	4.60750	0.16454	4.2786	4.9364
SediMite	11	5.28000	0.17186	4.9365	5.6235
Slurry Spray	11	5.28273	0.17186	4.9392	5.6263

Std Error uses a pooled estimate of error variance

Means Comparisons

Comparisons for each pair using Student's t

Confidence Quantile

t	Alpha
1.99897	0.05

LSD Threshold Matrix

Abs(Dif)-LSD	AquaBlok	Slurry Spray	SediMite	Control	Sand Control
AquaBlok	-0.34353	0.11153	0.11426	0.44517	0.79861
Slurry Spray	0.11153	-0.48583	-0.48310	-0.15220	0.19962
SediMite	0.11426	-0.48310	-0.48583	-0.15492	0.19690
Control	0.44517	-0.15220	-0.15492	-0.48583	-0.13401
Sand Control	0.79861	0.19962	0.19690	-0.13401	-0.46515

Positive values show pairs of means that are significantly different.

Connecting Letters Report

Level				Mean
AquaBlok	A			5.8150000
Slurry Spray		B		5.2827273
SediMite		B		5.2800000
Control		B	C	4.9490909
Sand Control			C	4.6075000

Levels not connected by same letter are significantly different.

Comparisons with a control using Dunnett's Method

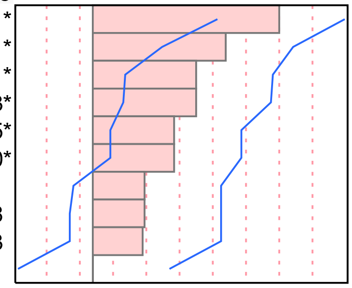
Control Group =
Control

Confidence Quantile

|d|	Alpha
2.49338	0.05

Ordered Differences Report

Level	- Level	Difference	Std Err Dif	Lower CL	Upper CL	p-Value
AquaBlok	Sand Control	1.207500	0.2045494	0.798612	1.616388	<.0001*
AquaBlok	Control	0.865909	0.2104796	0.445166	1.286652	0.0001*
Slurry Spray	Sand Control	0.675227	0.2379237	0.199625	1.150830	0.0061*
SediMite	Sand Control	0.672500	0.2379237	0.196897	1.148103	0.0063*
AquaBlok	SediMite	0.535000	0.2104796	0.114257	0.955743	0.0135*
AquaBlok	Slurry Spray	0.532273	0.2104796	0.111530	0.953015	0.0140*
Control	Sand Control	0.341591	0.2379237	-0.134012	0.817194	0.1561
Slurry Spray	Control	0.333636	0.2430409	-0.152195	0.819468	0.1748
SediMite	Control	0.330909	0.2430409	-0.154923	0.816741	0.1783
Slurry Spray	SediMite	0.002727	0.2430409	-0.483105	0.488559	0.9911



LSD Threshold Matrix

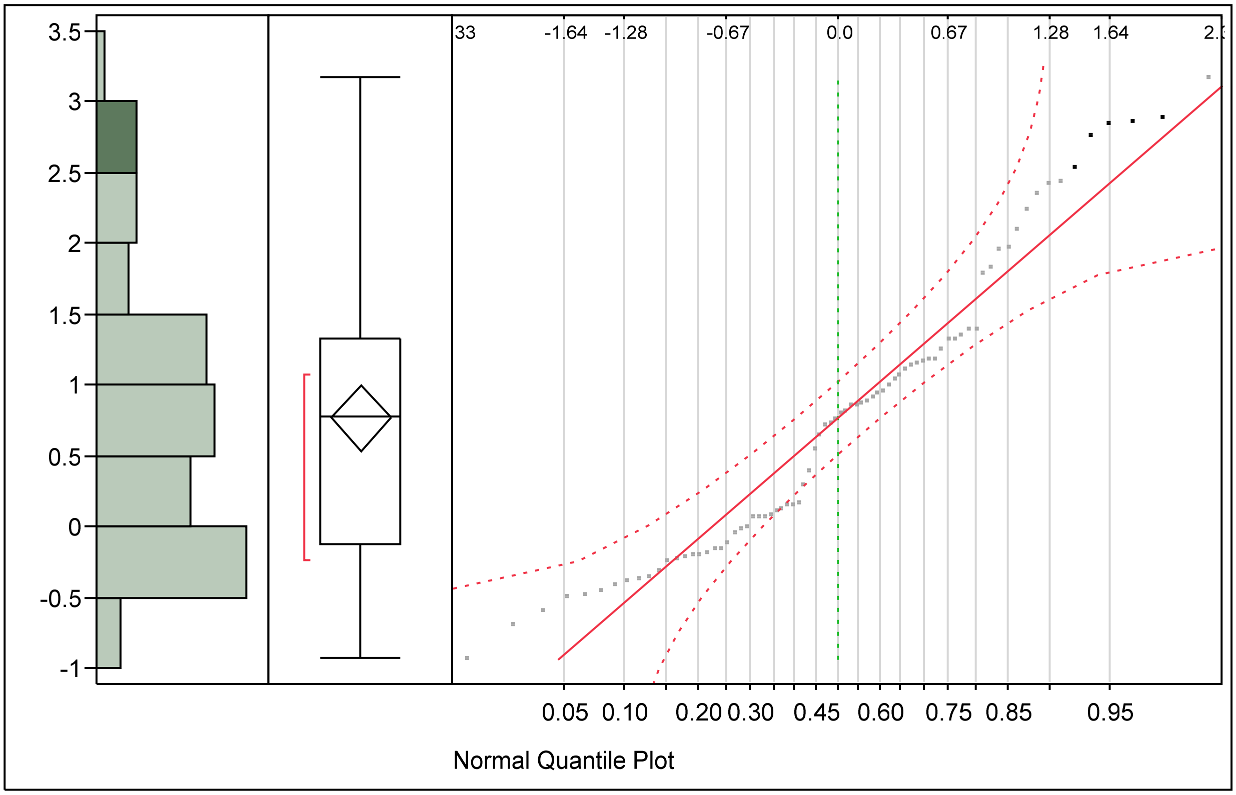
Level	Abs(Dif)-LSD	p-Value
AquaBlok	0.341	.
Slurry Spray	-0.27	0.4408
SediMite	-0.28	0.4479
Control	-0.61	1.0000
Sand Control	-0.25	0.4018

Positive values show pairs of means that are significantly different.

Lumbriculus Receptor Tissue to Bulk Solid Phase Partitioning Coefficient Statistical Evaluations

Demonstration of Relative Normal Fit for Log $K_{bulk/Lv}$ Data

Distributions Log-Kbulk/Lv



Quantiles

100.0%	maximum	3.17775
99.5%		3.17775
97.5%		2.89256
90.0%		2.42378
75.0%	quartile	1.3213
50.0%	median	0.78511
25.0%	quartile	-0.1169
10.0%		-0.385
2.5%		-0.6917
0.5%		-0.9316
0.0%	minimum	-0.9316

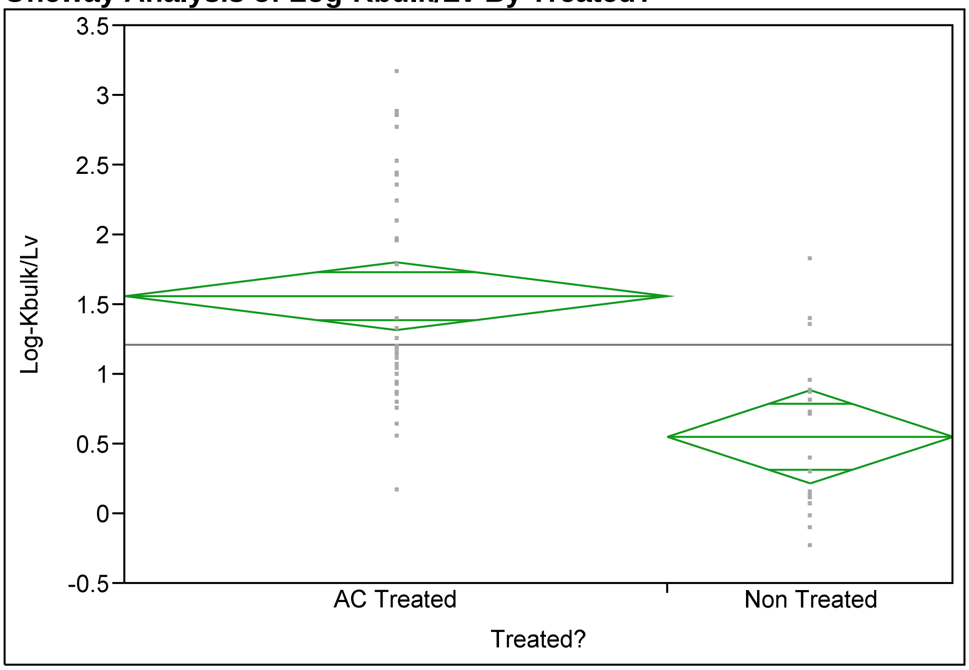
Summary Statistics

Mean	0.7733408
Std Dev	1.0098838
Std Err Mean	0.1143468
Upper 95% Mean	1.0010344
Lower 95% Mean	0.5456472
N	78

Post-Treatment $K_{bulk/Lv}$ evaluation of Treated vs. Non-Treated Test Plots

This ANOVA statistical analysis compared all post-treatment $K_{bulk/Lv}$ data by whether the treatment plots contained an Activated Carbon Amendment (AC Slurry, AquaBlok or SediMite) or were Control plots with no Activated Carbon (Control, Sand Control). Analysis determined that the two data sets were significantly different.

Oneway Analysis of Log-Kbulk/Lv By Treated?



Excluded Rows
23

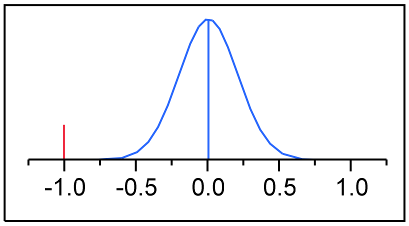
Oneway Anova
Summary of Fit

Rsquare	0.31111
Adj Rsquare	0.298112
Root Mean Square Error	0.726826
Mean of Response	1.215516
Observations (or Sum Wgts)	55

t Test
Non Treated-AC Treated

Assuming equal variances

Difference	-1.0083	t Ratio	-4.89237
Std Err Dif	0.2061	DF	53
Upper CL Dif	-0.5949	Prob > |t|	<.0001*
Lower CL Dif	-1.4217	Prob > t	1.0000
Confidence	0.95	Prob < t	<.0001*



Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Treated?	1	12.644469	12.6445	23.9353	<.0001*
Error	53	27.998647	0.5283		
C. Total	54	40.643116			

Means for Oneway Anova

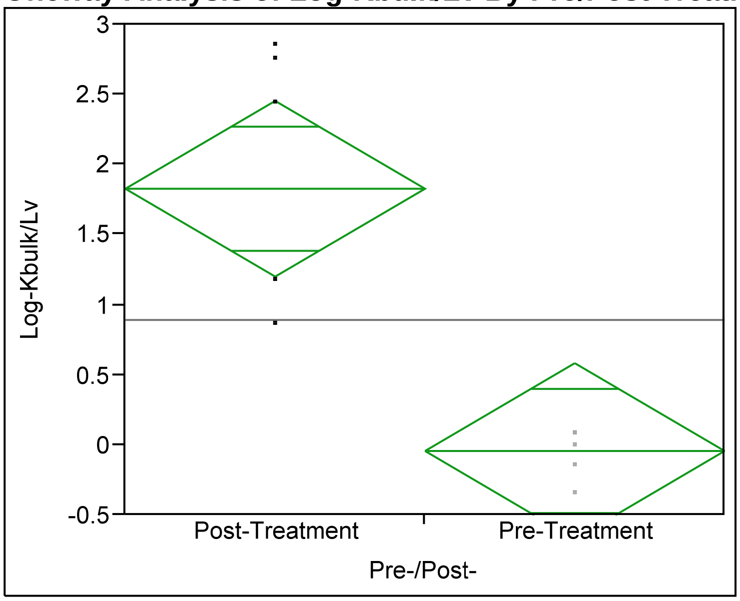
Level	Number	Mean	Std Error	Lower 95%	Upper 95%
AC Treated	36	1.56385	0.12114	1.3209	1.8068
Non Treated	19	0.55552	0.16675	0.2211	0.8900

Std Error uses a pooled estimate of error variance

ANOVA: $K_{bulk/Lv}$ Evaluation between Pre- and Post-Treatment for *AC Slurry Spray*

This ANOVA statistical analysis compared just AC Slurry (Slurry Spray) $K_{bulk/Lv}$ data between pre- and post-treatment sampling periods. Analysis determined that the pre- and post-treatment $K_{bulk/Lv}$ values were significantly different.

Oneway Analysis of Log-Kbulk/Lv By Pre/Post Treatment



Excluded Rows
66

Oneway Anova

Summary of Fit

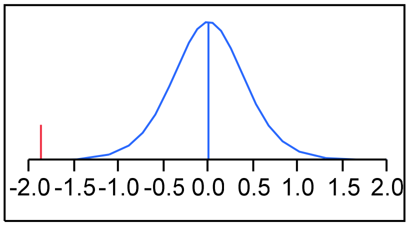
Rsquare	0.68867
Adj Rsquare	0.657537
Root Mean Square Error	0.689477
Mean of Response	0.893408
Observations (or Sum Wgts)	12

t Test

Pre-Treatment-Post-Treatment

Assuming equal variances

Difference	-1.8722	t Ratio	-4.70322
Std Err Dif	0.3981	DF	10
Upper CL Dif	-0.9853	Prob > |t|	0.0008*
Lower CL Dif	-2.7592	Prob > t	0.9996
Confidence	0.95	Prob < t	0.0004*



Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Pre-/Post-	1	10.515497	10.5155	22.1203	0.0008*
Error	10	4.753787	0.4754		
C. Total	11	15.269284			

Means for Oneway Anova

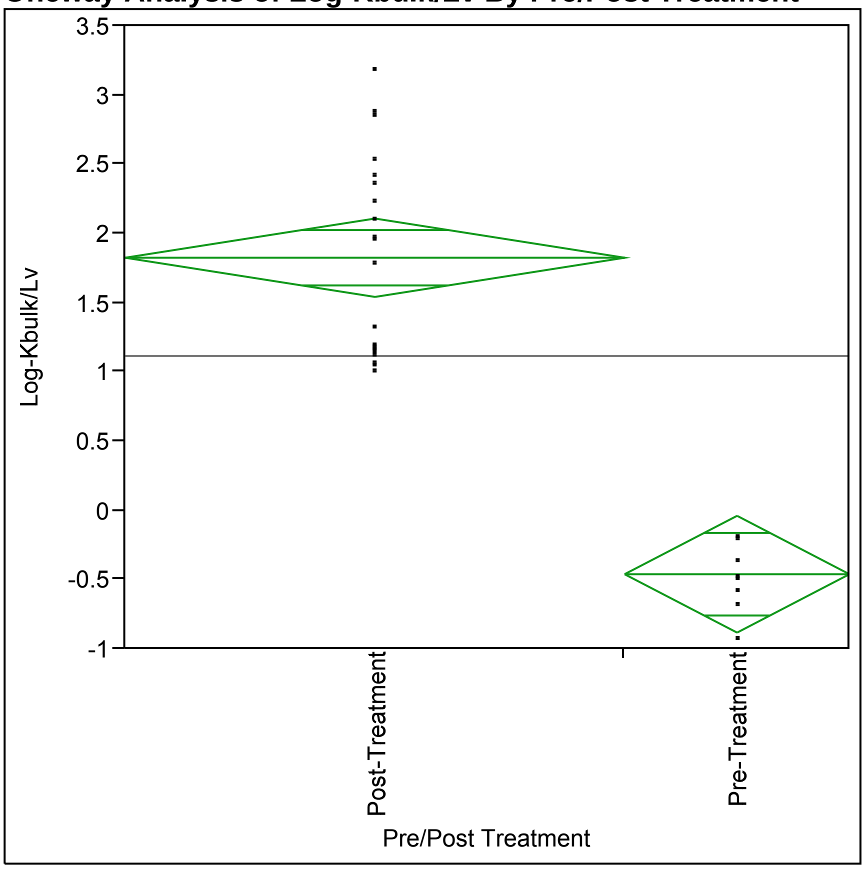
Level	Number	Mean	Std Error	Lower 95%	Upper 95%
Post-Treatment	6	1.8295	0.28148	1.202	2.4567
Pre-Treatment	6	-0.0427	0.28148	-0.670	0.5845

Std Error uses a pooled estimate of error variance

ANOVA: $K_{bulk/pw}$ Evaluation between Pre- and Post-Treatment for *AquaBlok*

This ANOVA statistical analysis compared just AquaBlok $K_{bulk/Lv}$ data between pre- and post-treatment sampling periods. Analysis determined that the pre- and post-treatment $K_{bulk/Lv}$ values were significantly different.

Oneway Analysis of Log-Kbulk/Lv By Pre/Post Treatment



Excluded Rows
49

Oneway Anova

Summary of Fit

Rsquare	0.759515
Adj Rsquare	0.750609
Root Mean Square Error	0.616816
Mean of Response	1.116842
Observations (or Sum Wgts)	29

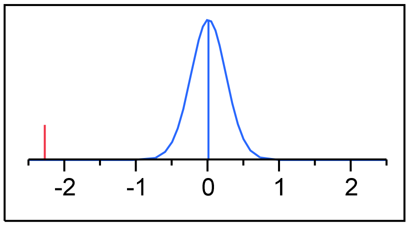
t Test

Pre-Treatment-Post-Treatment

Assuming equal variances

Difference	-2.2863	t Ratio	-9.23436

Std Err Dif	0.2476	DF	27
Upper CL Dif	-1.7783	Prob > |t|	<.0001*
Lower CL Dif	-2.7943	Prob > t	1.0000
Confidence	0.95	Prob < t	<.0001*



Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Pre/Post Treatment	1	32.443281	32.4433	85.2733	<.0001*
Error	27	10.272480	0.3805		
C. Total	28	42.715762			

Means for Oneway Anova

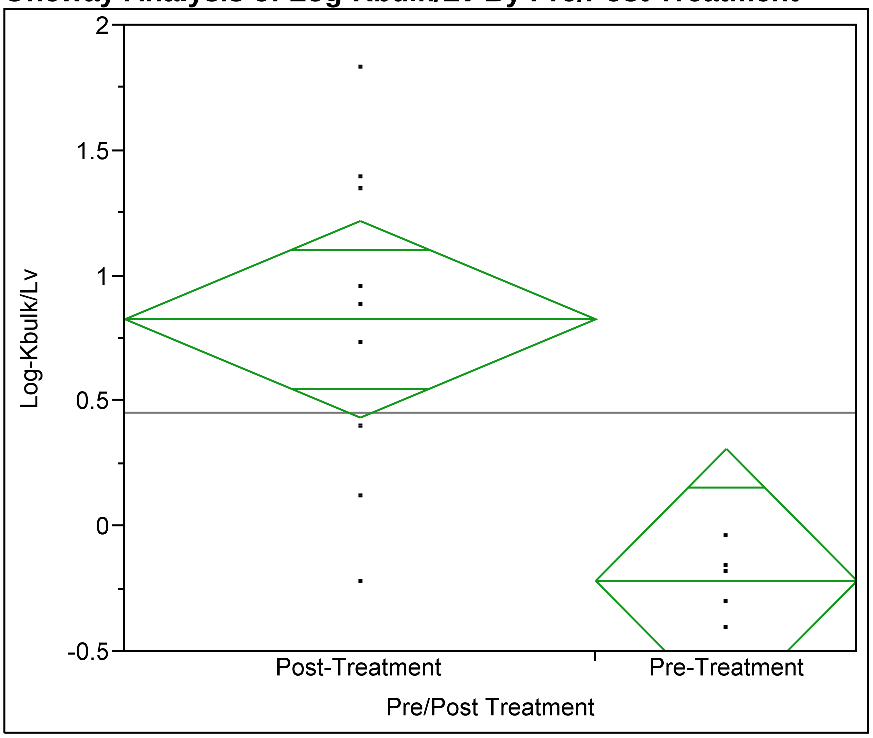
Level	Number	Mean	Std Error	Lower 95%	Upper 95%
Post-Treatment	20	1.8264	0.13792	1.543	2.109
Pre-Treatment	9	-0.4599	0.20561	-0.882	-0.038

Std Error uses a pooled estimate of error variance

ANOVA: $K_{bulk/Lv}$ Evaluation between Pre- and Post-Treatment for *Sand Control*

This ANOVA statistical analysis compared just Sand Control $K_{bulk/Lv}$ data between pre- and post-treatment sampling periods. Analysis determined that the pre- and post-treatment $K_{bulk/Lv}$ values were significantly different.

Oneway Analysis of Log-Kbulk/Lv By Pre/Post Treatment



Excluded Rows
64

Oneway Anova

Summary of Fit

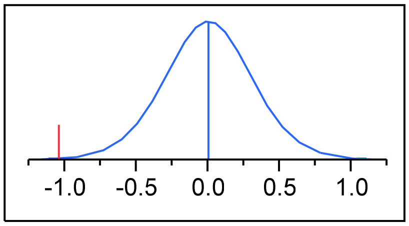
Rsquare	0.499851
Adj Rsquare	0.458172
Root Mean Square Error	0.540501
Mean of Response	0.455092
Observations (or Sum Wgts)	14

t Test

Pre-Treatment-Post-Treatment

Assuming equal variances

Difference	-1.0440	t Ratio	-3.46307
Std Err Dif	0.3015	DF	12
Upper CL Dif	-0.3872	Prob > |t|	0.0047*
Lower CL Dif	-1.7009	Prob > t	0.9977
Confidence	0.95	Prob < t	0.0023*



Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Pre/Post Treatment	1	3.5036114	3.50361	11.9928	0.0047*
Error	12	3.5057013	0.29214		
C. Total	13	7.0093127			

Means for Oneway Anova

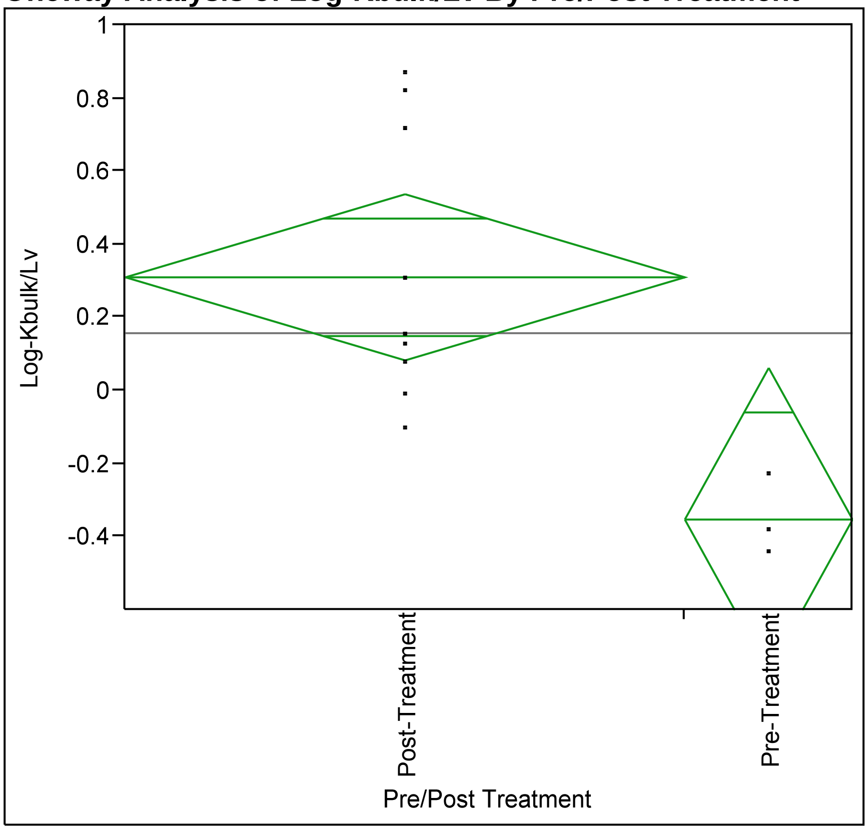
Level	Number	Mean	Std Error	Lower 95%	Upper 95%
Post-Treatment	9	0.82796	0.18017	0.4354	1.2205
Pre-Treatment	5	-0.21607	0.24172	-0.7427	0.3106

Std Error uses a pooled estimate of error variance

ANOVA: $K_{bulk/Lv}$ Evaluation between Pre- and Post-Treatment for *Control*

This ANOVA statistical analysis compared just Control (no treatment) $K_{bulk/Lv}$ data between pre- and post-treatment sampling periods. Analysis determined that the pre- and post-treatment $K_{bulk/Lv}$ values were significantly different.

Oneway Analysis of Log-Kbulk/Lv By Pre/Post Treatment



Excluded Rows
65

Oneway Anova

Summary of Fit

Rsquare	0.463742
Adj Rsquare	0.414991
Root Mean Square Error	0.326425
Mean of Response	0.157377
Observations (or Sum Wgts)	13

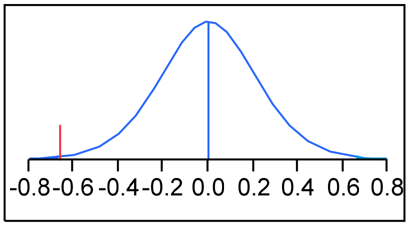
t Test

Pre-Treatment-Post-Treatment

Assuming equal variances

Difference	-0.6627	t Ratio	-3.08424

Std Err Dif	0.2149	DF	11
Upper CL Dif	-0.1898	Prob > |t|	0.0104*
Lower CL Dif	-1.1357	Prob > t	0.9948
Confidence	0.95	Prob < t	0.0052*



Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Pre/Post Treatment	1	1.0135892	1.01359	9.5125	0.0104*
Error	11	1.1720850	0.10655		
C. Total	12	2.1856742			

Means for Oneway Anova

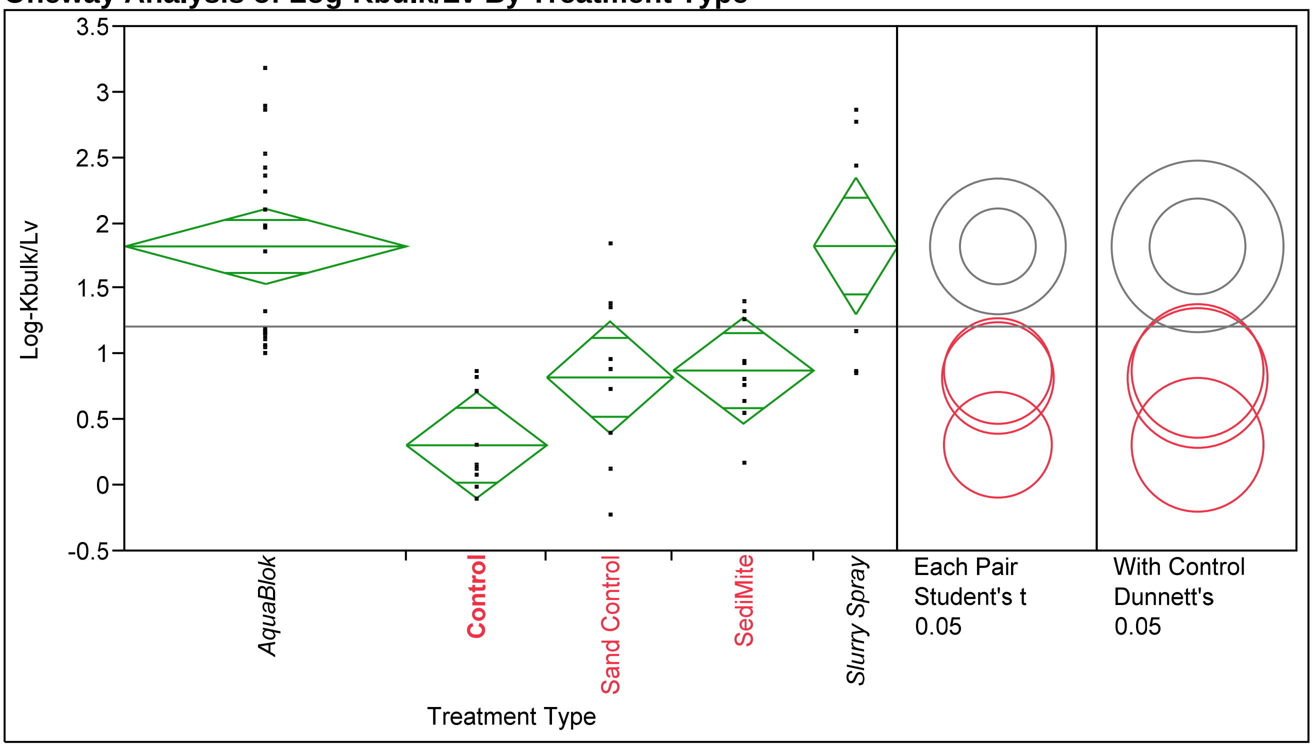
Level	Number	Mean	Std Error	Lower 95%	Upper 95%
Post-Treatment	10	0.31032	0.10322	0.0831	0.53751
Pre-Treatment	3	-0.35242	0.18846	-0.7672	0.06238

Std Error uses a pooled estimate of error variance

ANOVA: Post Treatment $K_{bulk/Lv}$ evaluation of Different Treatments; Student's T Test: Determine Significance between Treatment Types; Control Dunnett's: Determine Significance between Control and All other Treatments

An ANOVA statistical analysis and Student's T means statistical comparison was conducted on all post-treatment $K_{bulk/Lv}$ data by "Treatment Type" (AquaBlok, Control, Sand Control, and Slurry Spray (AC)). ANOVA determined that Treatment Type was a significant variable within the data set (for $K_{bulk/Lv}$). Student's T means statistical comparison determined that the AquaBlok and Slurry Spray (AC) were statistically separate from the Control and Sand Control. Dunnett's mean statistical comparison (with control set as the control) confirmed that AquaBlok and Slurry Spray were the only Treatment different than the control.

Oneway Analysis of Log-Kbulk/Lv By Treatment Type



Excluded Rows
23

Oneway Anova
Summary of Fit

Rsquare	0.501933
Adj Rsquare	0.462088
Root Mean Square Error	0.636286
Mean of Response	1.215516
Observations (or Sum Wgts)	55

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Treatment Type	4	20.400139	5.10003	12.5970	<.0001*
Error	50	20.242977	0.40486		

Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
C. Total	54	40.643116			

Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
AquaBlok	20	1.82637	0.14228	1.541	2.1121
Control	10	0.31032	0.20121	-0.094	0.7145
Sand Control	9	0.82796	0.21210	0.402	1.2540
SediMite	10	0.87941	0.20121	0.475	1.2836
Slurry Spray	6	1.82951	0.25976	1.308	2.3513

Std Error uses a pooled estimate of error variance

Means Comparisons
Comparisons for each pair using Student's t
Confidence Quantile

t	Alpha
2.00856	0.05

LSD Threshold Matrix

Abs(Dif)-LSD	Slurry Spray	AquaBlok	SediMite	Sand Control	Control
Slurry Spray	-0.7379	-0.5917	0.2901	0.3280	0.8592
AquaBlok	-0.5917	-0.4041	0.4520	0.4854	1.0211
SediMite	0.2901	0.4520	-0.5715	-0.5358	-0.0025
Sand Control	0.3280	0.4854	-0.5358	-0.6025	-0.0696
Control	0.8592	1.0211	-0.0025	-0.0696	-0.5715

Positive values show pairs of means that are significantly different.

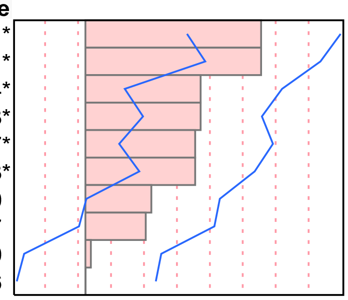
Connecting Letters Report

Level			Mean
Slurry Spray	A		1.8295125
AquaBlok	A		1.8263703
SediMite		B	0.8794083
Sand Control		B	0.8279619
Control		B	0.3103165

Levels not connected by same letter are significantly different.

Ordered Differences Report

Level	- Level	Difference	Std Err Dif	Lower CL	Upper CL	p-Value
Slurry Spray	Control	1.519196	0.3285765	0.85923	2.179161	<.0001*
AquaBlok	Control	1.516054	0.2464324	1.02108	2.011028	<.0001*
Slurry Spray	Sand Control	1.001551	0.3353520	0.32798	1.675125	0.0044*
AquaBlok	Sand Control	0.998408	0.2553965	0.48543	1.511387	0.0003*
Slurry Spray	SediMite	0.950104	0.3285765	0.29014	1.610070	0.0057*
AquaBlok	SediMite	0.946962	0.2464324	0.45199	1.441936	0.0003*
SediMite	Control	0.569092	0.2845556	-0.00245	1.140639	0.0510
Sand Control	Control	0.517645	0.2923531	-0.06956	1.104854	0.0827
SediMite	Sand Control	0.051446	0.2923531	-0.53576	0.638655	0.8610
Slurry Spray	AquaBlok	0.003142	0.2961749	-0.59174	0.598027	0.9916



Comparisons with a control using Dunnett's Method

Control Group =
Control

Confidence Quantile

|d|	Alpha
2.52130	0.05

LSD Threshold Matrix

Level	Abs(Dif)-LSD	p-Value
Slurry Spray	0.691	0.0001*
AquaBlok	0.895	<.0001*
SediMite	-0.15	0.1561
Sand Control	-0.22	0.2406
Control	-0.72	1.0000

Positive values show pairs of means that are significantly different.

Appendix E: Plant Community Report

Introduction

The overall objective of ESTCP Project ER-0825 was to demonstrate and validate in situ wetland remediation technologies designed to sequester contaminants in wetlands. As described in the Draft Final Report (NAVFAC ESC, 2013), this was accomplished through establishment of a stratified-random plot study design that included treatment applications of Activated Carbon (AC), SediMite, AquaBlok®, Sand Control, and Blank Controls (i.e., no treatments), followed by chemical analyses, and laboratory bioaccumulation testing. To fully understand the effectiveness of various treatments, ecological evaluations were also necessary to assess the efficacy of the sequestration agent application, and to ensure that the wetland community at each treatment plot was not substantially altered (or recovers from any short-term impacts) due to implementation of the in situ treatment. This was accomplished through quantitative assessments and qualitative observations of plant community structure (this Appendix), resident benthic macroinvertebrate community structure (Appendix B), and an evaluation of plant nutrient uptake (Appendix C).

The Field Demonstration was performed at Canal Creek, Aberdeen Proving Ground (APG), Aberdeen, Maryland. Canal Creek is located on the Edgewood peninsula, which is situated between the Gunpowder River to the west and the Bush River to the east. The Canal Creek Marsh and Landfill area is located within the Canal Creek Study Area (CCSA), which is a 1,600-acre study area in the northern region of the Edgewood Area. The demonstration site is located along the West Branch of Canal Creek, just above Hanlon Rd (Figure 1). The West Branch originates as a non-tidal stream, which becomes a meandering tidal creek downstream of Magnolia Road. The creek is bordered by 45 acres of tidal marsh emergent vegetation with small areas of scrub-shrub and forested wetlands.

Methods

Vegetation monitoring included an evaluation of survivorship and health of resident plants measured as total percent cover, species richness, and diversity (i.e., Shannon-Wiener Diversity Index) for the layers present (i.e., herbs, shrubs/saplings, vines and/or trees). Diversity indices are useful because they take into account both species richness and the relative abundance of each species to quantify how well species are represented within a community. Invasive plant species were also documented, in terms of percent cover within each sample plot, and dense mono-culture stands were mapped throughout the field demonstration wetland on aerial photographs with lateral extents confirmed in the field. Monitoring was conducted both pre- and post-application to assess plant community health including documentation of early senescence, yellowing or stunting of vegetation during post-treatment sampling events. Plants were identified to species level, and percent cover was estimated using a modified Daubenmire cover class system (Figure 2).

To accomplish this task efficiently, sub-plots (one rectangular and one circular) were placed within each of the 8 X 8 meter (m) treatment plots. Rectangular plots were used because, when placed parallel to the major environmental gradient, they encompass more heterogeneity and recover greater species richness than round or square plots, and because vegetation cover alone is the important metric, plot size is not a factor (Barbour et al., 1999). Therefore, relatively small 10 m^2 (2 X 5 m) plots that can be easily sampled by one plant biologist were placed in the southeastern corner of each 8 X 8 m treatment plot (Figure 2). Circular (4-m diameter) plots were placed at the center of each treatment plot to ensure we obtained a good representation of conditions within each treatment plot.

Standard statistical analyses were used to evaluate differences among treatment plots and between treatment plots and control plots within each sampling event. Vegetation metrics were also tested

in plots pre- versus post-application; however, interpretation of these data should be assessed with caution given the natural temporal variations encountered.

STATA 11.0 and JMP tutorials (SAS, 2013) were used to complete the statistical analyses. Treatment groups were analyzed with One Way Analysis of Variation (ANOVA), and Student's T-test individual pairwise comparison of each group mean for normally distributed data, and Pearson's test (r) for correlations. Non-parametric tests included Kruskal-Wallis rank test and Spearman Rank test (r_s) for correlations. Statistical differences were assumed at the alpha = 0.05 level. The remediation technology was considered successful if the post-treatment plant community metric condition was within 25% of the pre-treatment conditions and/or concurrent controls. A 25% change in conditions has been previously used by USEPA and other agencies as a quantifiable measurement of ecological significance (e.g., USEPA, 1994).

Results

The Field Demonstration wetland is approximately 2 acres in size and borders approximately 680 linear feet of Canal Creek (Figure 3). Approximately 32% (0.64 acres) of the total demonstration area consists of a dense mono-culture stand of common reed (*Phragmites australis*), an invasive plant species in Maryland. Another 33% (0.65 acres) of the demonstration area is dominated by narrow-leaved cattail (*Typha angustifolia*), which is not considered "invasive"; however, it is often considered an aggressive colonizer and tends to form dense mono-culture stands. The remaining portions of the field demonstration area were characterized as shallow emergent marsh (19%; 0.38 acres) and deep emergent marsh (16%; 0.34 acres).

A total of 49 plant species were observed within the field demonstration wetland (Table 1), the majority of which were herbaceous perennials, sedges, rushes and aquatic emergent plants (n=32). Also identified were shrubs (6), grasses (4), vines (4), trees (2) and one (1) sub-aquatic vascular plant.

Twenty-four (24) treatment plots were placed within the demonstration wetland and the vegetation was surveyed at three (3) separate times: November 2009 (T0), June 2011 (T1), and October 2011 (T2). Photographs of each plot are included in Attachment A and raw data from the surveys are presented in Attachment B. Common reed persists as a dense mono-culture stand (>90% cover) in only four (4) of the plots, plus one (1) additional plot with >60% cover. Common reed was observed in lower densities (3-20% cover) within an additional nine (9) plots. Narrow-leaved cattails were present in seven (7) plots with >60% cover, and ten (10) plots with 3-20% cover. One other invasive species observed within the field demonstration wetland was bladderwort (*Utricularia sp.*). This plant was observed in only two (2) plots and within the river itself.

Species richness ranged from only one (1) to nineteen (19) species in a treatment plot and on average, significantly increased between sampling events (i.e., from T0 to T2) (F = 8.351, p = 0.001, d.f. = 2; Figure 4). Species richness in plots dominated by common reed tended to be low ranging from only one (1) to five (5) (mean = 4.5) species. As expected, species richness was higher in plots dominated by shallow marsh or with a mixture of shallow and deep marsh habitats (6-13 species, mean = 9.0). Deep marsh habitats dominated by Arrow arum (*Peltandra virginica*) had only four (4) to five (5)(mean 4.7) species present. Interestingly, the narrow-leaved cattail dominated plots tended to exhibit the highest species richness ranging from ten (10) to nineteen (19) (mean = 12.9) species.

Within each sampling event, vegetation cover tended to be high in each plot with overlapping vegetation layers often resulting in percent cover ranging to well over 100% (Figure 4). At T0, T1

and T2, only nine (9), two (2) and six (6) plots had <90% cover, respectively. There was no difference in relative cover between sampling events (F = 0.537, p = 0.466, d.f. = 2). Diversity at T0 was not different from T1 or T2 (F = 0.713, p = 0.494, d.f. = 2).

Vegetation characteristics within each of the 24 survey plots were significantly correlated between pre- and post-treatment periods. Correlations for species richness were particularly high for T0 versus T1 (r = 0.69; $p < 0.05$) and T0 versus T2 (r = 0.81; $p < 0.05$). Similarly, T1 versus T2 were also highly correlated (r = 0.90; $p < 0.05$). Relative cover and diversity were not significantly correlated for T0 versus T1, but they were for T0 versus T2 (Cover: $r_s = 0.67$; $p < 0.05$; Diversity: r = 0.51; $p < 0.05$).

The 24 plots were placed into one of five treatments: AquaBlok® (n=8), SediMite (n=4), Slurry Spray (i.e., a slurry of powdered activated carbon; n=4), Sand Control (n=4) and a Blank Control (i.e., no treatment; n=4). Because post-treatment sample results (T1 and T2) were not different, these data were pooled for analyses (Figure 4 and 5). As with the plot-by-plot analysis above, mean relative cover and species richness within treatment groups generally increased over time (i.e., comparing T0 to T1 and T2 data; Figure 5).

No differences among treatments were observed post-application for relative cover (F = 0.646, p = 0.633, d.f. = 4), or species richness (F = 2.063, p = 0.102, d.f. = 4; Figure 5). Species diversity among treatments was marginally significant (F = 2.515, p = 0.055, d.f. = 4), and some differences between treatments and controls were also observed (Figure 6). The SediMite treatment plots (mean = 0.718 ± 0.16) exhibited significantly lower diversity when compared to the control (mean = 1.23 ± 0.16, t = 2.017, p = 0.029) and the Sand Control (mean = 1.37 ± 0.16, t = 2.017, p = 0.006).

The percent change in species richness, diversity, and relative cover from T0 to post-treatment (average of T1 and T2 combined) was highly variable among plots and within treatments (Figure 7). On a plot-by-plot basis, we observed both increases and decreases in plant metrics from pre- to post-treatment time frames that were greater than 25% and these changes occurred within both treatment plots and control plots. However, the average percent change in diversity, richness and relative cover within treatments and controls was in a positive direction, ranging from 8-58% (mean = 20.7%) for diversity, 22-59% (mean = 34.0%) for richness and 0.8-51% (mean = 25.5%) for relative cover.

Discussion

In general, the results of the statistical analyses suggest that the treatments did not have a significant adverse impact on plant species composition within the field demonstration wetland. And when changes did occur, they were often in a positive direction. However, interpreting and drawing conclusions on these analyses should be met with caution given the natural temporal variation encountered within this wetland system. And despite efforts to control for spatial variation by breaking the demonstration wetland into “high quality” and “low quality” wetlands areas, a significant amount of variation was still encountered within a particular sampling event (i.e., at T0, T1 or T2). These types of variability are typical of natural systems, which is why monitoring vegetation composition is only one approach used in this program to assess ecological impacts of different treatment regimes.

High correlations were observed between pre- and post-treatment plant metrics indicate that these metrics did not significantly change over time. In addition, no differences between treatments and controls for relative cover and species richness were observed within T0, T1 and T2 sampling events. Lower diversity (marginally significant) was observed within post-treatment SediMite plots

(using pooled T1 and T2 data for post-treatment timeframe) when compared to the controls. However, this may be attributed to natural variation as diversity, and species richness within SediMite plots prior to any treatments (i.e., at T0) also tended to be lower than in the control plots (Figure 5).

Although mean relative cover and species richness within treatment plots appeared to be lower at T0 when compared to T1 and T2, these observed differences are likely temporal in nature. Aboveground portions of most soft, fleshy herbaceous and aquatic emergent species completely disappear following the first frost, which can result in a significant decrease in plant community structure over a short time period. For example, the T0 sampling event conducted in November 2009 may have represented a post-frost sampling event while the T2 sampling event in October 2011 may have taken place prior to any significant frost, resulting in greater species richness and relative cover.

Changes in diversity, richness and relative cover between pre- and post-treatment time periods were observed that were greater than the 25% of plant community metric condition used by the USEPA. However, with the exception of 5 plots (APG-20 and APG-9 treated with Aquablok, APG-10 in the Sand Control, APG-18 treated with SediMite, and APG-2 treated with the Slurry Spray; Figure 7), these changes were generally in a positive direction on a plot-by-plot basis, and on average within treatments were in a positive direction (see Figure 8). As described above, these variations are likely attributable to high spatial and temporal variability observed within these data. The scattered nature of these reductions in species diversity or relative cover does not indicate a clear trend of adverse impacts due to the application of the treatments themselves.

Visual inspections of vegetation during each of the post-treatment sampling events did not identify any early senescence, yellowing or stunting of vegetation. However, in June 2011 (T1), dark staining was observed on newly emerged sensitive fern (*Onoclea sensibilis*) in plots treated with AquaBlok® (Figure 9). Because Canal Creek is tidally influenced, it was presumed that the dark colored, fine-textured component of the AquaBlok® was carried upward in elevation with the rising tide, and stained all portions of the plants that were submerged. It is unknown what impact this physical disturbance might have on the plants, but it is possible that dark staining on the leaf surfaces could temporarily impact the photosynthesis process and gas exchange between the leaf surface and atmosphere via stomata.

References

Barbour, M.T., J. Gerritsen, B.D. Snyder, and J.B. Stribling. 1999. Rapid Bioassessment Protocols for Use in Streams and Wadeable Rivers: Periphyton, Benthic Macroinvertebrates and Fish, Second Edition. EPA 841-B-99-002. U.S. Environmental Protection Agency; Office of Water; Washington, D.C.

Naval Facilities Engineering Command Engineering Service Center (NAVFAC ESC). 2013. Draft Final Report (Version 0). In Situ Wetland Restoration Demonstration. ESTCP Project Number ER-0825. February.

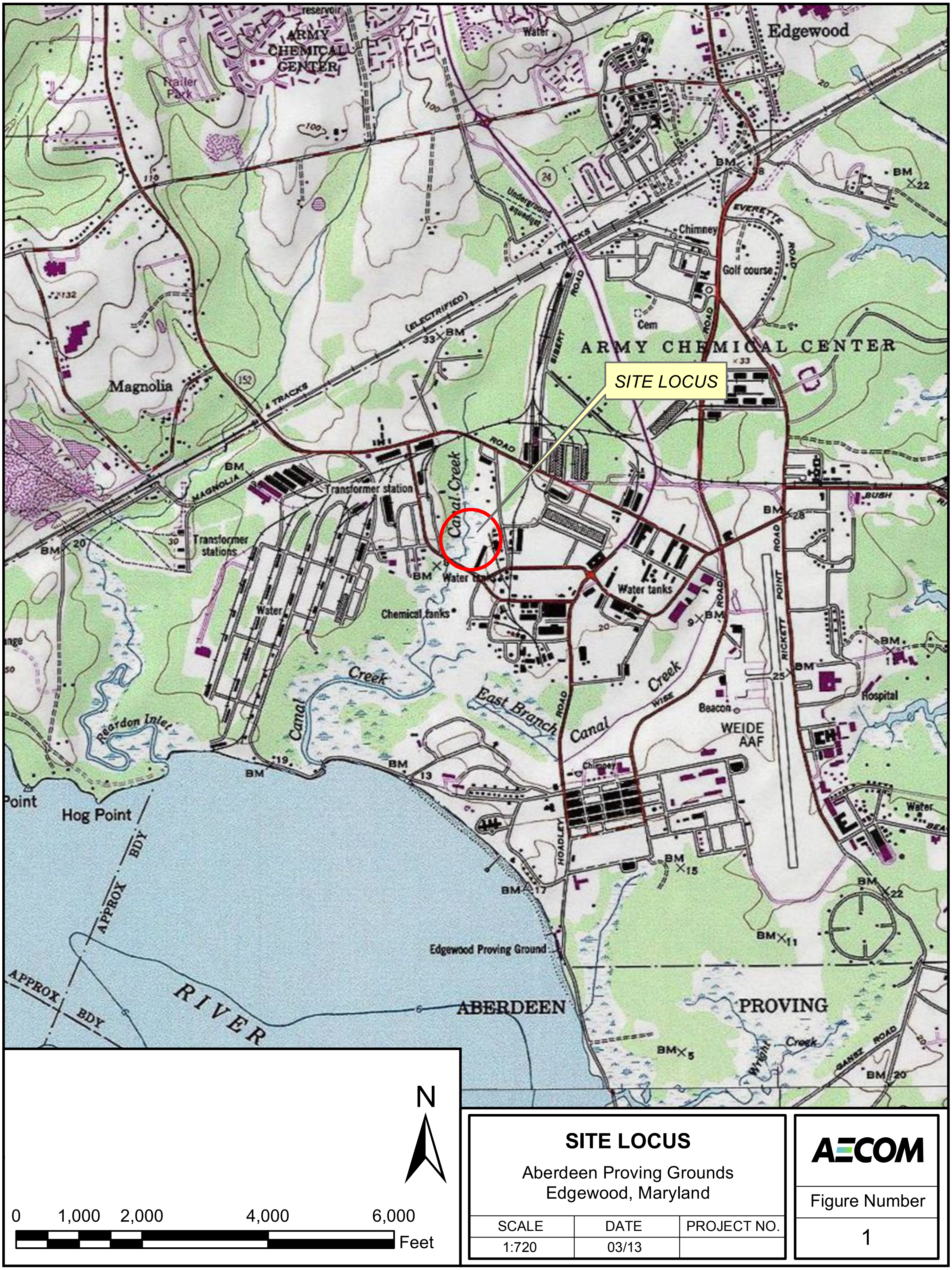
USEPA. 1994. Briefing Report to the Science Advisory Board on the Equilibrium Partitioning Approach for Predicting Metal Bioavailability in Sediments and the Derivation of Sediment Quality Criteria for Metals. December 1994. USEPA. Office of Water and Office of Research and Development, EPA-822-D-94-002.

Table 1. Plant species observed in the Canal Creek Field Demonstration wetland.

Common Name	Latin Name	Group
Small water plantain	*Alisma subcordatum*	Herbaceous Perennials
Swamp milkweed	*Asclepias incarnata*	Herbaceous Perennials
Aster	*Aster sp.*	Herbaceous Perennials
Nodding Bur-Marigold	*Bidens cernua*	Herbaceous Perennials
False nettle	*Boehmeria cylindrica*	Herbaceous Perennials
Hairy sedge	*Carex lacustris*	Sedges and Rushes
Lurid sedge	*Carex lurida*	Sedges and Rushes
Carex	*Carex scoparia*	Sedges and Rushes
Fox sedge	*Carex stipata/vulpinoidea*	Sedges and Rushes
Tussock sedge	*Carex stricta*	Sedges and Rushes
Buttonbush	*Cephalanthus occidentalis*	Shrubs
Water hemlock	*Cicuta maculata*	Herbaceous Perennials
Whorled coreopsis	*Coreopsis verticillata*	Herbaceous Perennials
Silky dogwood	*Cornus amomum*	Shrubs
Deer-tongue grass	*Dichanthelium clandestinum*	Grass
Spike rush	*Eleocharis sp.*	Sedges and Rushes
Marsh bedstraw	*Galium palustre*	Herbaceous Perennials
Rose mallow	*Hibiscus palustris*	Shrubs
Jewelweed	*Impatiens capensis*	Herbaceous Perennials
Blue flag iris	*Iris versicolor*	Herbaceous Perennials
Canada rush	*Juncus canadensis*	Sedges and Rushes
Soft rush	*Juncus effusus*	Sedges and Rushes
Rice cutgrass	*Leersia oryzoides*	Grass
Water horehound	*Lycopus americanus*	Herbaceous Perennials
Swamp candles	*Lysimachia terrestris*	Herbaceous Perennials
Sweetgum	*Liquidambar styraciflua*	Tree
Climbing boneset	*Mikania scandens*	Vine
Black gum	*Nyssa sylvatica*	Tree
Sensitive fern	*Onoclea sensibilis*	Herbaceous Perennials
Virginia creeper	*Parthenoisus quinquefolia*	Vine
Arrow arum	*Peltandra virginica*	Aquatic Emergent
Common reed	*Phragmites australis*	Grass
Halberd-leaved tearthumb	*Polygonum arifolium*	Herbaceous Perennials
Water Smartweed	*Polygonum punctatum*	Herbaceous Perennials
Arrow-leaved tearthumb	*Polygonum sagittatum*	Herbaceous Perennials
Pickerelweed	*Pontederia cordata*	Aquatic Emergent
Swamp rose	*Rosa palustris*	Shrubs
Elderberry	*Sambucus canadensis*	Shrubs
Woolgrass	*Scirpus cyperinus*	Sedges and Rushes
Soft-stem bulrush	*Scirpus validus*	Sedges and Rushes
Water parsnip	*Sium suave*	Herbaceous Perennials
Bur reed	*Sparganium sp.*	Aquatic Emergent
Marsh fern	*Thelypteris Thelypteroides*	Herbaceous Perennials
Poison ivy	*Toxiciodendron radicans*	Vine

Table 1. (Cont.)

Common Name	Latin Name	Group
Narrow-leaved cattail	*Typha angustifolia*	Aquatic Emergent
Bladderwort	*Utricularia sp.*	Sub-Aquatic
Arrowwood	*Viburnum dentatum*	Shrubs
Fox grape	*Vitis labrusca*	Vine
Wild rice	*Zizania aquatica*	Grass



SITE LOCUS

Aberdeen Proving Grounds
Edgewood, Maryland

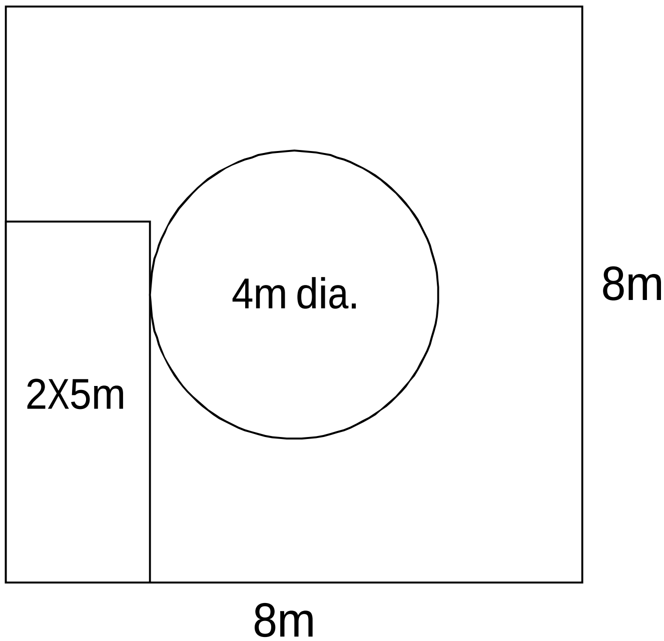
SCALE	DATE	PROJECT NO.
1:720	03/13	

AECOM

Figure Number

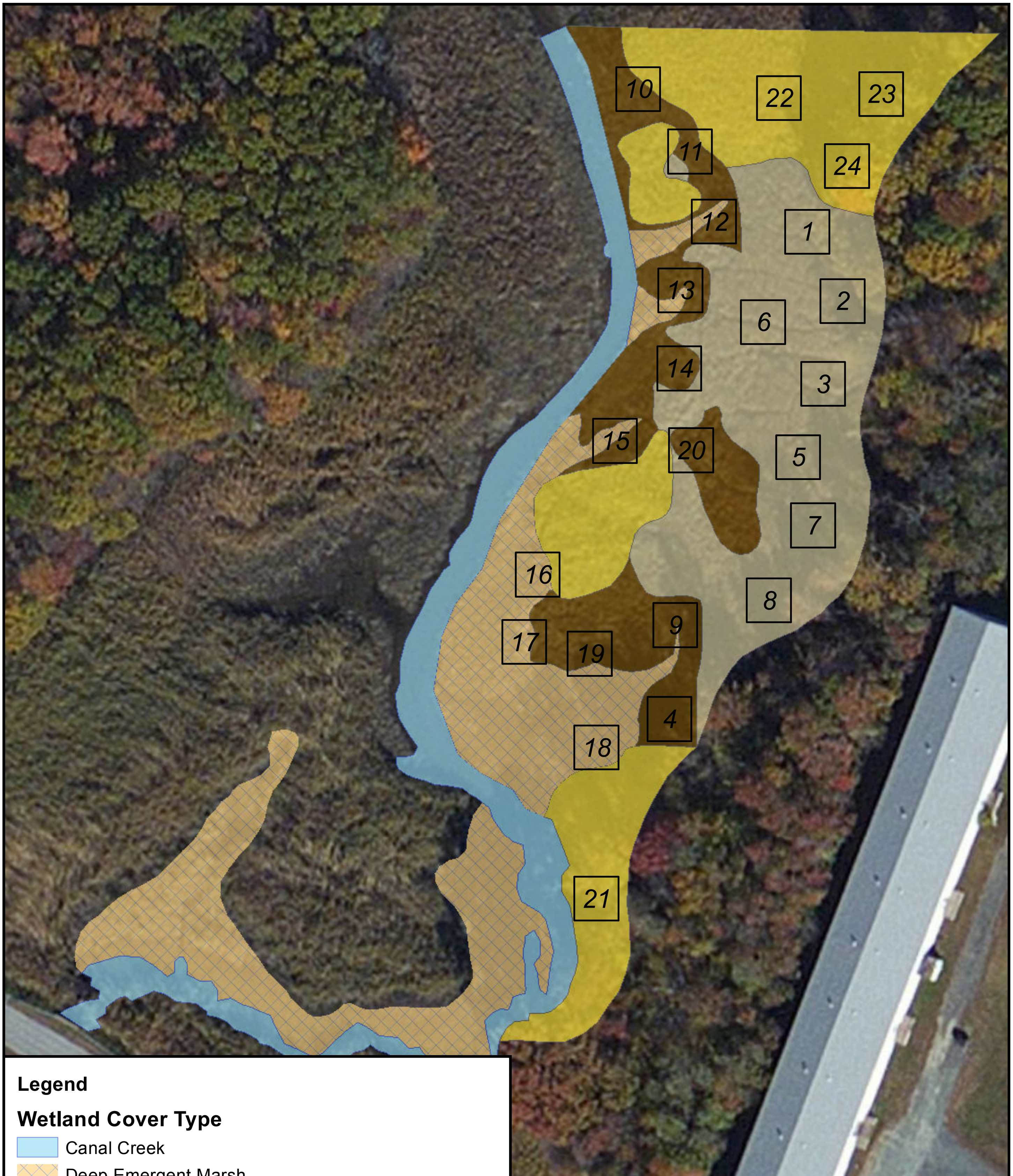
1

Figure 2. 8X8m treatment plot and vegetation sampling sub-plot layout (left), and modified Daubenmire cover class system (right).



Cover Classes

<1	0.5
1-5	3.0
6-15	10.5
16-25	20.5
26-50	38.0
51-75	63.0
76-95	85.5
96-100	98.0



Legend

Wetland Cover Type

- Canal Creek
- Deep Emergent Marsh
- Shallow Emergent Marsh
- Narrow-leaved Cattail
- Phragmites

0 40 80 160 240 Feet

VEGETATION COVER TYPES
CANAL CREEK STUDY SITE
Aberdeen Proving Grounds
Edgewood, Maryland

SCALE	DATE	PROJECT NO.
1:960	03/13	

AECOM

Figure Number

3

Figure 4. Mean relative cover, species richness and diversity ±SE among all plots within each sampling event. Range of values recorded are presented above each bar.

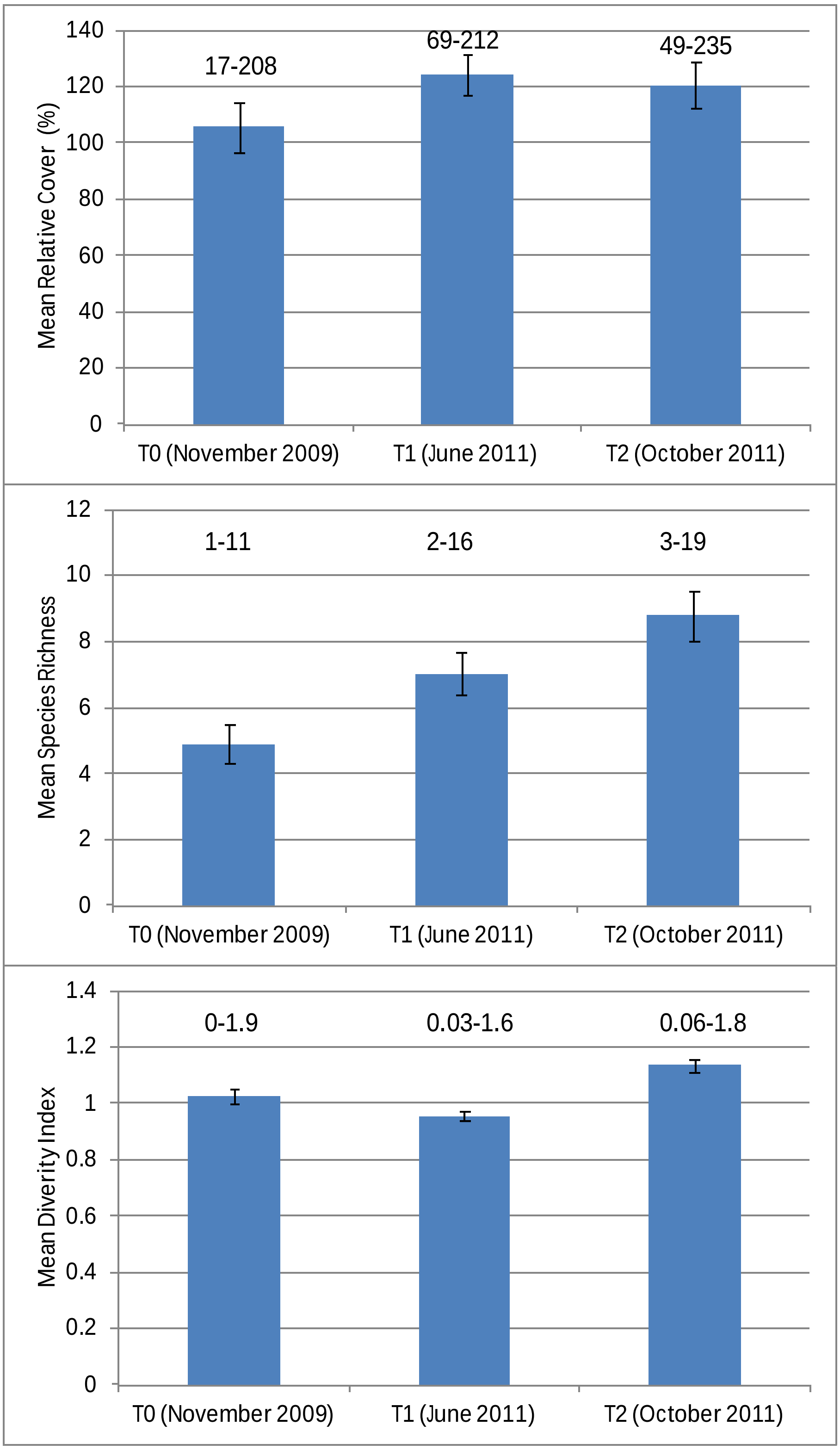


Figure 5. Mean relative cover, species richness and diversity by treatment ±SE, for each of the three sampling events.

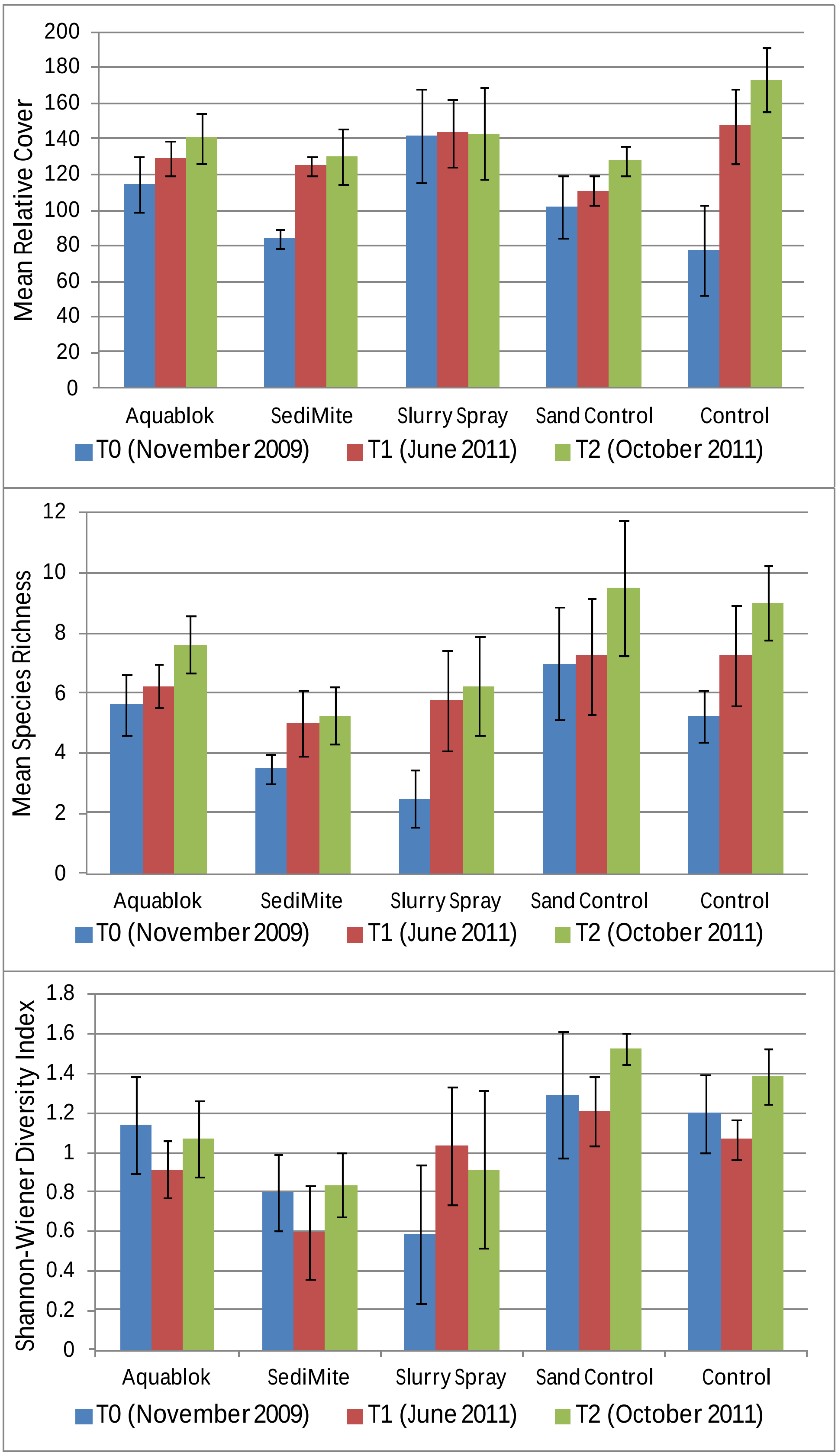


Figure 6. Graphical representations of One-Way ANOVA on treatment:diversity index. T1 and T2 data are pooled. Treatments with different letters are significantly different from one-another at $p < 0.05$. Each diamond displays statistical information about the grouped data. The horizontal line at the center of the diamond displays the group mean and the smaller horizontal lines above and below represent an overlap marks which display statistical significance for groups with the same sample size. The 95% confidence interval for each group is represented by top and bottom of the diamond corners of the diamond, or height of the diamond which is calculated as (1-alpha) x 100 confidence interval for each group. The horizontal size of the diamond is representative of the sample size of the group.

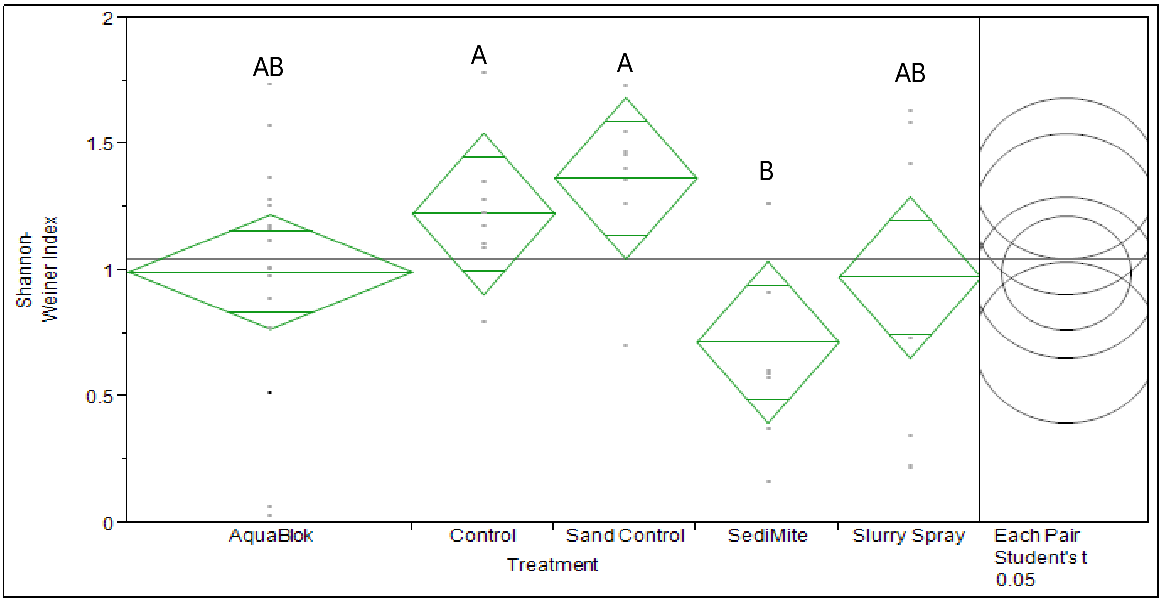


Figure 7. Percent change in measured plant metrics from pre-treatment (T0) to post-treatment (mean of T1 and T2) sampling events on a plot-by-plot basis.

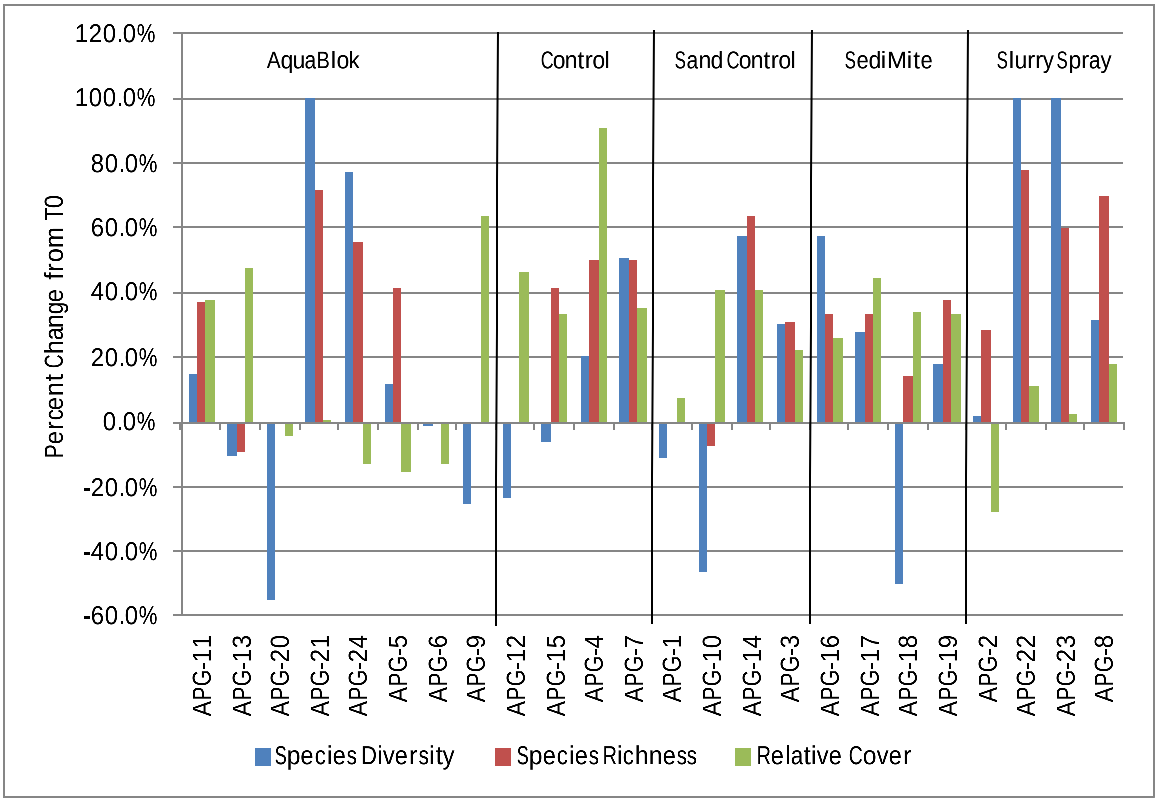


Figure 8. Average percent change (±SE) in measured plant metrics from pre-treatment (T0) to post-treatment (mean of T1 and T2) sampling events.

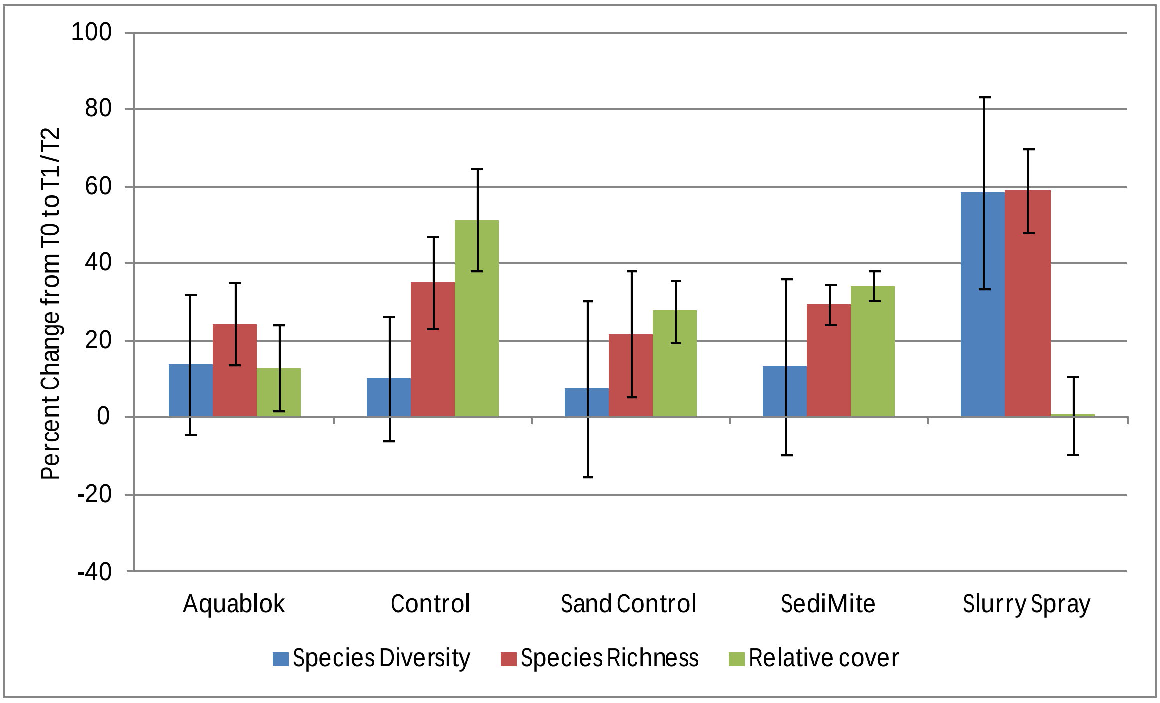


Figure 9. APG-5, Aquablok plot. Vegetation (or portions thereof) that become inundated each day during tidal fluctuations are stained gray/black. “A” and “B” are partially submerged during high tide, “C” is completely submerged, and “D” was tall enough to be above high tide waters.

APG-01

APG-02

APG-03

APG-04

APG-05

APG-06


APG-07


APG-08

APG-09

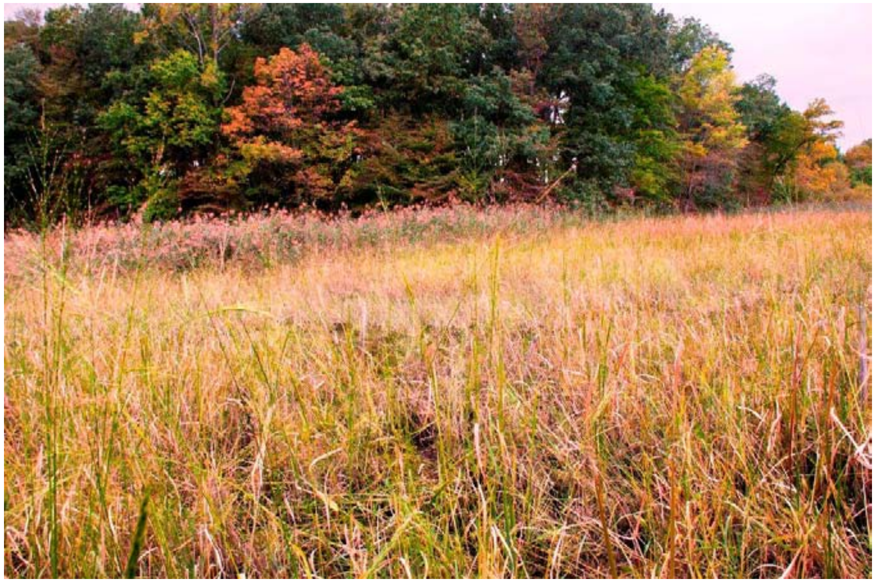
APG-10


APG-11


APG-12

APG-13

APG-14



APG-15

APG-16

APG-17

APG-18

APG-19

APG-20

APG-21

APG-22

APG-23

APG-24

ATTACHMENT B
VEGETATION DATA

Time Zero - November 2009

Common Name	Latin Name	Date	Cover Class 4m Circle Plot	Plot ID	Treatment
Arrow Arum	*Peltandra virginica*	11/1/2009	3.0	APG-1	Sand Control
Arrow-leaved Tearthumb	*Polygonum sagittatum*	11/1/2009	3.0	APG-1	Sand Control
Climbing boneset	*Mikania scandens*	11/1/2009	10.5	APG-1	Sand Control
Narrow-leaved Cattail	*Typha angustifolia*	11/1/2009	63.0	APG-1	Sand Control
Rice cutgrass	*Leersia oryzoides*	11/1/2009	10.5	APG-1	Sand Control
Rose Mallow	*Hibiscus palustris*	11/1/2009	10.5	APG-1	Sand Control
Sphagnum Moss	*Sphagnum* sp.	11/1/2009	10.5	APG-1	Sand Control
Arrow Arum	*Peltandra virginica*	11/1/2009	10.5	APG-10	Sand Control
Canada Rush	*Juncus canadensis*	11/1/2009	10.5	APG-10	Sand Control
Common Reed	*Phragmites australis*	11/1/2009	10.5	APG-10	Sand Control
Marsh Bedstraw	*Galium palustre*	11/1/2009	10.5	APG-10	Sand Control
Rice cutgrass	*Leersia oryzoides*	11/1/2009	10.5	APG-10	Sand Control
Water Smartweed	*Polygonum punctatum*	11/1/2009	10.5	APG-10	Sand Control
Wild Rice	*Zizania aquatica*	11/1/2009	10.5	APG-10	Sand Control
Arrow Arum	*Peltandra virginica*	11/1/2009	38.0	APG-11	Aquablok
Canada Rush	*Juncus canadensis*	11/1/2009	3.0	APG-11	Aquablok
Common Reed	*Phragmites australis*	11/1/2009	20.5	APG-11	Aquablok
Marsh Bedstraw	*Galium palustre*	11/1/2009	10.5	APG-11	Aquablok
Rice cutgrass	*Leersia oryzoides*	11/1/2009	3.0	APG-11	Aquablok
Water Smartweed	*Polygonum punctatum*	11/1/2009	20.5	APG-11	Aquablok
Arrow Arum	*Peltandra virginica*	11/1/2009	10.5	APG-12	Control
Canada rush	*Juncus canadensis*	11/1/2009	10.5	APG-12	Control
Common Reed	*Phragmites australis*	11/1/2009	10.5	APG-12	Control
Marsh Bedstraw	*Galium palustre*	11/1/2009	3.0	APG-12	Control
Rice cutgrass	*Leersia oryzoides*	11/1/2009	20.5	APG-12	Control
Water Smartweed	*Polygonum punctatum*	11/1/2009	3.0	APG-12	Control
Arrow Arum	*Peltandra virginica*	11/1/2009	10.5	APG-13	Aquablok
Canada rush	*Juncus canadensis*	11/1/2009	10.5	APG-13	Aquablok
Narrow-leaved Cattail	*Typha angustifolia*	11/1/2009	10.5	APG-13	Aquablok
Rice cutgrass	*Leersia oryzoides*	11/1/2009	3.0	APG-13	Aquablok
Water Smartweed	*Polygonum punctatum*	11/1/2009	10.5	APG-13	Aquablok
Wild Rice	*Zizania aquatica*	11/1/2009	38.0	APG-13	Aquablok
Arrow Arum	*Peltandra virginica*	11/1/2009	10.5	APG-14	Sand Control
Wild Rice	*Zizania aquatica*	11/1/2009	63.0	APG-14	Sand Control
Deer-tongue Grass	*Dichanthelium clandestinum*	11/1/2009	38.0	APG-15	Control
Marsh Bedstraw	*Galium palustre*	11/1/2009	10.5	APG-15	Control
Soft Rush	*Juncus effusus*	11/1/2009	63.0	APG-15	Control
Swamp Rose	*Rosa palustris*	11/1/2009	10.5	APG-15	Control
Wool Grass	*Scirpus cyperinus*	11/1/2009	3.0	APG-15	Control
Arrow Arum	*Peltandra virginica*	11/1/2009	3.0	APG-16	SediMite
Common Reed	*Phragmites australis*	11/1/2009	3.0	APG-16	SediMite
Wild Rice	*Zizania aquatica*	11/1/2009	85.5	APG-16	SediMite
Arrow Arum	*Peltandra virginica*	11/1/2009	10.5	APG-17	SediMite
Canada rush	*Juncus canadensis*	11/1/2009	10.5	APG-17	SediMite
Wild Rice	*Zizania aquatica*	11/1/2009	63.0	APG-17	SediMite
Arrow Arum	*Peltandra virginica*	11/1/2009	38.0	APG-18	SediMite
Common Reed	*Phragmites australis*	11/1/2009	10.5	APG-18	SediMite
Wild Rice	*Zizania aquatica*	11/1/2009	20.5	APG-18	SediMite
Arrow Arum	*Peltandra virginica*	11/1/2009	38.0	APG-19	SediMite
Canada rush	*Juncus canadensis*	11/1/2009	38.0	APG-19	SediMite
Common Reed	*Phragmites australis*	11/1/2009	3.0	APG-19	SediMite
Narrow-leaved Cattail	*Typha angustifolia*	11/1/2009	10.5	APG-19	SediMite
Wild Rice	*Zizania aquatica*	11/1/2009	3.0	APG-19	SediMite
Canada rush	*Juncus canadensis*	11/1/2009	10.5	APG-2	Slurry Spray

ATTACHMENT B
VEGETATION DATA

Time Zero - November 2009

Common Name	Latin Name	Date	Cover Class 4m Circle Plot	Plot ID	Treatment
Climbing boneset	*Mikania scandens*	11/1/2009	38.0	APG-2	Slurry Spray
Marsh Bedstraw	*Galium palustre*	11/1/2009	85.5	APG-2	Slurry Spray
Narrow-leaved Cattail	*Typha angustifolia*	11/1/2009	63.0	APG-2	Slurry Spray
Rice cutgrass	*Leersia oryzoides*	11/1/2009	10.5	APG-2	Slurry Spray
Arrow Arum	*Peltandra virginica*	11/1/2009	10.5	APG-20	Aquablok
Arrow-leaved Tearthumb	*Polygonum sagittatum*	11/1/2009	3.0	APG-20	Aquablok
Canada rush	*Juncus canadensis*	11/1/2009	63.0	APG-20	Aquablok
Clayton's Bedstraw	*Galium tinctorium*	11/1/2009	3.0	APG-20	Aquablok
Climbing boneset	*Mikania scandens*	11/1/2009	10.5	APG-20	Aquablok
Narrow-leaved Cattail	*Typha angustifolia*	11/1/2009	38.0	APG-20	Aquablok
Rice cutgrass	*Leersia oryzoides*	11/1/2009	3.0	APG-20	Aquablok
Rose Mallow	*Hibiscus palustris*	11/1/2009	10.5	APG-20	Aquablok
Water Smartweed	*Polygonum punctatum*	11/1/2009	3.0	APG-20	Aquablok
Common Reed	*Phragmites australis*	11/1/2009	100.0	APG-21	Aquablok
Common Reed	*Phragmites australis*	11/1/2009	100.0	APG-22	Slurry Spray
Common Reed	*Phragmites australis*	11/1/2009	100.0	APG-23	Slurry Spray
Common Reed	*Phragmites australis*	11/1/2009	85.5	APG-24	Aquablok
Wild Rice	*Zizania aquatica*	11/1/2009	3.0	APG-24	Aquablok
Arrow Arum	*Peltandra virginica*	11/1/2009	3.0	APG-3	Sand Control
Clayton's Bedstraw	*Galium tinctorium*	11/1/2009	3.0	APG-3	Sand Control
Climbing boneset	*Mikania scandens*	11/1/2009	10.5	APG-3	Sand Control
Marsh Fern	*Thelypteris Thelypteroides*	11/1/2009	3.0	APG-3	Sand Control
Narrow-leaved Cattail	*Typha angustifolia*	11/1/2009	85.5	APG-3	Sand Control
Rice cutgrass	*Leersia oryzoides*	11/1/2009	10.5	APG-3	Sand Control
Rose Mallow	*Hibiscus palustris*	11/1/2009	10.5	APG-3	Sand Control
Small Bedstraw	*Galium trifidum*	11/1/2009	3.0	APG-3	Sand Control
Sphagnum Moss	*Sphagnum* sp.	11/1/2009	3.0	APG-3	Sand Control
Water Smartweed	*Polygonum punctatum*	11/1/2009	3.0	APG-3	Sand Control
Ditch Stonecrop	*Penthorum sedoides*	11/1/2009	3.0	APG-4	Control
Narrow-leaved Cattail	*Typha angustifolia*	11/1/2009	3.0	APG-4	Control
Wild Rice	*Zizania aquatica*	11/1/2009	10.5	APG-4	Control
Climbing boneset	*Mikania scandens*	11/1/2009	3.0	APG-5	Aquablok
Fox grape	*Vitis labrusca*	11/1/2009	10.5	APG-5	Aquablok
Narrow-leaved Cattail	*Typha angustifolia*	11/1/2009	85.5	APG-5	Aquablok
Rose Mallow	*Hibiscus palustris*	11/1/2009	10.5	APG-5	Aquablok
Sensitive Fern	*Onoclea sensibilis*	11/1/2009	63.0	APG-5	Aquablok
Arrow Arum	*Peltandra virginica*	11/1/2009	3.0	APG-6	Aquablok
Canada rush	*Juncus canadensis*	11/1/2009	63.0	APG-6	Aquablok
Climbing boneset	*Mikania scandens*	11/1/2009	20.5	APG-6	Aquablok
Marsh Bedstraw	*Galium palustre*	11/1/2009	3.0	APG-6	Aquablok
Narrow-leaved Cattail	*Typha angustifolia*	11/1/2009	63.0	APG-6	Aquablok
Rice cutgrass	*Leersia oryzoides*	11/1/2009	10.5	APG-6	Aquablok
Rose Mallow	*Hibiscus palustris*	11/1/2009	10.5	APG-6	Aquablok
Climbing boneset	*Mikania scandens*	11/1/2009	10.5	APG-7	Control
Marsh Fern	*Thelypteris Thelypteroides*	11/1/2009	3.0	APG-7	Control
Narrow-leaved Cattail	*Typha angustifolia*	11/1/2009	85.5	APG-7	Control
Rose Mallow	*Hibiscus palustris*	11/1/2009	3.0	APG-7	Control
Water Parsnip	*Sium suave*	11/1/2009	3.0	APG-7	Control
Water Smartweed	*Polygonum punctatum*	11/1/2009	3.0	APG-7	Control
Narrow-leaved Cattail	*Typha angustifolia*	11/1/2009	85.5	APG-8	Slurry Spray
Rose Mallow	*Hibiscus palustris*	11/1/2009	38.0	APG-8	Slurry Spray
Sensitive Fern	*Onoclea sensibilis*	11/1/2009	38.0	APG-8	Slurry Spray
Arrow Arum	*Peltandra virginica*	11/1/2009	10.5	APG-9	Aquablok
Canada Rush	*Juncus canadensis*	11/1/2009	10.5	APG-9	Aquablok

Time Zero - November 2009

Common Name	Latin Name	Date	Cover Class 4m Circle Plot	Plot ID	Treatment
Climbing boneset	*Mikania scandens*	11/1/2009	3.0	APG-9	Aquablok
Narrow-leaved Cattail	*Typha angustifolia*	11/1/2009	3.0	APG-9	Aquablok
Rice cutgrass	*Leersia oryzoides*	11/1/2009	20.5	APG-9	Aquablok
Rose Mallow	*Hibiscus palustris*	11/1/2009	3.0	APG-9	Aquablok
Small Bedstraw	*Galium trifidum*	11/1/2009	3.0	APG-9	Aquablok
Water Smartweed	*Polygonum punctatum*	11/1/2009	3.0	APG-9	Aquablok

Modified Daubenmire cover class system

Cover Classes

<1	0.5
1-5	3.0
6-15	10.5
16-25	20.5
26-50	38.0
51-75	63.0
76-95	85.5
96-100	98.0

ATTACHMENT B
VEGETATION DATA

Time One - June 2011

Common Name	**Latin Name**	**Date**	**Cover Class 4m Circle Plot**	**Cover Class 2X5m Plot**	**Plot ID**	**Treatment**	**Wetland Quality**
Arrow Arum	*Peltandra virginica*	06/01/11	38	38	APG-1	Sand Control	Low Value
Arrow-leaved Tearthumb	*Polygonum sagittatum*	06/01/11	0.5	0.5	APG-1	Sand Control	Low Value
Canada rush	*Juncus canadensis*	06/01/11	0	3	APG-1	Sand Control	Low Value
Common reed	*Phragmites australis*	06/01/11	20.5	20.5	APG-1	Sand Control	Low Value
Jewelweed	*Impatiens capensis*	06/01/11	0	0.5	APG-1	Sand Control	Low Value
Marsh Bedstraw	*Galium palustre*	06/01/11	0	0.5	APG-1	Sand Control	Low Value
Narrow-leaved cattail	*Typha angustifolia*	06/01/11	63	85.5	APG-1	Sand Control	Low Value
Rice cutgrass	*Leersia oryzoides*	06/01/11	0	10.5	APG-1	Sand Control	Low Value
Rose mallow	*Hibiscus palustris*	06/01/11	10.5	10.5	APG-1	Sand Control	Low Value
Arrow arum	*Peltandra virginica*	06/01/11	38	85.5	APG-10	Sand Control	High Value
Canada rush	*Juncus canadensis*	06/01/11	20.5	3	APG-10	Sand Control	High Value
Common reed	*Phragmites australis*	06/01/11	63	0	APG-10	Sand Control	High Value
Rice cutgrass	*Leersia oryzoides*	06/01/11	0.5	10.5	APG-10	Sand Control	High Value
Swamp candles	*Lysimachia terrestris*	06/01/11	3	3	APG-10	Sand Control	High Value
Wild rice	*Zizania aquatica*	06/01/11	3	3	APG-10	Sand Control	High Value
Arrow arum	*Peltandra virginica*	06/01/11	63	38	APG-11	Aquablok	High Value
Canada rush	*Juncus canadensis*	06/01/11	10.5	0	APG-11	Aquablok	High Value
Common reed	*Phragmites australis*	06/01/11	10.5	3	APG-11	Aquablok	High Value
Narrow-leaved cattail	*Typha angustifolia*	06/01/11	3	63	APG-11	Aquablok	High Value
Rice cutgrass	*Leersia oryzoides*	06/01/11	20.5	3	APG-11	Aquablok	High Value
Rose mallow	*Hibiscus palustris*	06/01/11	3	3	APG-11	Aquablok	High Value
Water parsnip	*Sium suave*	06/01/11	0.5	0	APG-11	Aquablok	High Value
Wild rice	*Zizania aquatica*	06/01/11	10.5	0.5	APG-11	Aquablok	High Value
Arrow arum	*Peltandra virginica*	06/01/11	38	85.5	APG-12	Control	High Value
Canada rush	*Juncus canadensis*	06/01/11	38	20.5	APG-12	Control	High Value
Common reed	*Phragmites australis*	06/01/11	0.5	0	APG-12	Control	High Value
Narrow-leaved cattail	*Typha angustifolia*	06/01/11	0.5	0.5	APG-12	Control	High Value
Soft-stem bulrush	*Scirpus validus*	06/01/11	0	0.5	APG-12	Control	High Value
Wild rice	*Zizania aquatica*	06/01/11	10.5	10.5	APG-12	Control	High Value
Arrow arum	*Peltandra virginica*	06/01/11	63	38	APG-13	Aquablok	High Value
Canada rush	*Juncus canadensis*	06/01/11	63	10.5	APG-13	Aquablok	High Value
Rice cutgrass	*Leersia oryzoides*	06/01/11	10.5	0	APG-13	Aquablok	High Value
Swamp candles	*Lysimachia terrestris*	06/01/11	3	0	APG-13	Aquablok	High Value
Wild rice	*Zizania aquatica*	06/01/11	20.5	20.5	APG-13	Aquablok	High Value
Arrow arum	*Peltandra virginica*	06/01/11	38	38	APG-14	Sand Control	High Value
Bladderwort	*Utricularia sp.*	06/01/11	3	3	APG-14	Sand Control	High Value
Canada rush	*Juncus canadensis*	06/01/11	0.5	20.5	APG-14	Sand Control	High Value
Narrow-leaved cattail	*Typha angustifolia*	06/01/11	3	3	APG-14	Sand Control	High Value
Wild rice	*Zizania aquatica*	06/01/11	63	38	APG-14	Sand Control	High Value
Arrow arum	*Peltandra virginica*	06/01/11	63	63	APG-15	Control	High Value
Canada rush	*Juncus canadensis*	06/01/11	63	20.5	APG-15	Control	High Value
Common reed	*Phragmites australis*	06/01/11	0.5	0	APG-15	Control	High Value
Rice cutgrass	*Leersia oryzoides*	06/01/11	3	10.5	APG-15	Control	High Value
Soft-stem bulrush	*Scirpus validus*	06/01/11	0.5	0	APG-15	Control	High Value
Swamp candles	*Lysimachia terrestris*	06/01/11	10.5	0	APG-15	Control	High Value
Wild rice	*Zizania aquatica*	06/01/11	20.5	10.5	APG-15	Control	High Value
Arrow arum	*Peltandra virginica*	06/01/11	98	98	APG-16	SediMite	High Value
Canada rush	*Juncus canadensis*	06/01/11	0.5	3	APG-16	SediMite	High Value
Common reed	*Phragmites australis*	06/01/11	3	0	APG-16	SediMite	High Value
Soft-stem bulrush	*Scirpus validus*	06/01/11	0.5	0	APG-16	SediMite	High Value
Wild rice	*Zizania aquatica*	06/01/11	10.5	0.5	APG-16	SediMite	High Value
Arrow arum	*Peltandra virginica*	06/01/11	63	98	APG-17	SediMite	High Value
Canada rush	*Juncus canadensis*	06/01/11	63	10.5	APG-17	SediMite	High Value
Narrow-leaved cattail	*Typha angustifolia*	06/01/11	0.5	0	APG-17	SediMite	High Value
Soft-stem bulrush	*Scirpus validus*	06/01/11	0	0	APG-17	SediMite	High Value
Wild rice	*Zizania aquatica*	06/01/11	10.5	10.5	APG-17	SediMite	High Value
Arrow arum	*Peltandra virginica*	06/01/11	98	98	APG-18	SediMite	High Value
Common reed	*Phragmites australis*	06/01/11	0.5	0.5	APG-18	SediMite	High Value
Soft rush	*Juncus effusus*	06/01/11	0	0.5	APG-18	SediMite	High Value
Wild rice	*Zizania aquatica*	06/01/11	20.5	10.5	APG-18	SediMite	High Value
Arrow arum	*Peltandra virginica*	06/01/11	38	63	APG-19	SediMite	High Value
Bur reed	*Sparganium sp.*	06/01/11	3	0	APG-19	SediMite	High Value
Canada rush	*Juncus canadensis*	06/01/11	63	63	APG-19	SediMite	High Value
Common reed	*Phragmites australis*	06/01/11	0.5	0	APG-19	SediMite	High Value
Narrow-leaved cattail	*Typha angustifolia*	06/01/11	10.5	0	APG-19	SediMite	High Value
Pickerelweed	*Pontederia cordata*	06/01/11	20.5	10.5	APG-19	SediMite	High Value
Soft-stem bulrush	*Scirpus validus*	06/01/11	0.5	0.5	APG-19	SediMite	High Value

ATTACHMENT B
VEGETATION DATA

Time One - June 2011

Common Name	Latin Name	Date	Cover Class 4m Circle Plot	Cover Class 2X5m Plot	Plot ID	Treatment	Wetland Quality
Wild rice	*Zizania aquatica*	06/01/11	3	63	APG-19	SediMite	High Value
Arrow arum	*Peltandra virginica*	06/01/11	38	10.5	APG-2	Slurry Spray	Low Value
Canada rush	*Juncus canadensis*	06/01/11	10.5	38	APG-2	Slurry Spray	Low Value
Carex	*Carex lacustris*	06/01/11	0	0.5	APG-2	Slurry Spray	Low Value
False nettle	*Boehmeria cylindrica*	06/01/11	10.5	10.5	APG-2	Slurry Spray	Low Value
Jewelweed	*Impatiens capensis*	06/01/11	0	0.5	APG-2	Slurry Spray	Low Value
Marsh Bedstraw	*Galium palustre*	06/01/11	20.5	63	APG-2	Slurry Spray	Low Value
Narrow-leaved cattail	*Typha angustifolia*	06/01/11	85.5	85.5	APG-2	Slurry Spray	Low Value
Rose Mallow	*Hibiscus palustris*	06/01/11	3	3	APG-2	Slurry Spray	Low Value
Arrow arum	*Peltandra virginica*	06/01/11	20.5	38	APG-20	Aquablok	High Value
Canada rush	*Juncus canadensis*	06/01/11	98	3	APG-20	Aquablok	High Value
Carex	*Carex scoparia*	06/01/11	0.5	0	APG-20	Aquablok	High Value
False nettle	*Boehmeria cylindrica*	06/01/11	3	0	APG-20	Aquablok	High Value
Lurid Sedge	*Carex lurida*	06/01/11	0.5	0	APG-20	Aquablok	High Value
Narrow-leaved cattail	*Typha angustifolia*	06/01/11	3	38	APG-20	Aquablok	High Value
Rice cutgrass	*Leersia oryzoides*	06/01/11	3	20.5	APG-20	Aquablok	High Value
Rose mallow	*Hibiscus palustris*	06/01/11	3	0	APG-20	Aquablok	High Value
Water horehound	*Lycopus americanus*	06/01/11	3	0	APG-20	Aquablok	High Value
Wild rice	*Zizania aquatica*	06/01/11	0	10.5	APG-20	Aquablok	High Value
Arrow arum	*Peltandra virginica*	06/01/11	3	0.5	APG-21	Aquablok	High Value
Arrow-leaved tearthumb	*Polygonum sagittatum*	06/01/11	0.5	0	APG-21	Aquablok	High Value
Common reed	*Phragmites australis*	06/01/11	98	98	APG-21	Aquablok	High Value
Swamp candles	*Lysimachia terrestris*	06/01/11	0.5	0	APG-21	Aquablok	High Value
Arrow arum	*Peltandra virginica*	06/01/11	20.5	10.5	APG-22	Slurry Spray	Low Value
Common reed	*Phragmites australis*	06/01/11	85.5	63	APG-22	Slurry Spray	Low Value
Rice cutgrass	*Leersia oryzoides*	06/01/11	10.5	3	APG-22	Slurry Spray	Low Value
Rose mallow	*Hibiscus palustris*	06/01/11	3	0	APG-22	Slurry Spray	Low Value
Swamp candles	*Lysimachia terrestris*	06/01/11	3	3	APG-22	Slurry Spray	Low Value
Water parsnip	*Sium suave*	06/01/11	0	0.5	APG-22	Slurry Spray	Low Value
Arrow arum	*Peltandra virginica*	06/01/11	3	10.5	APG-23	Slurry Spray	Low Value
Common reed	*Phragmites australis*	06/01/11	98	85.5	APG-23	Slurry Spray	Low Value
Arrow arum	*Peltandra virginica*	06/01/11	10.5	38	APG-24	Aquablok	Low Value
Black gum	*Nyssa sylvatica*	06/01/11	3	0	APG-24	Aquablok	Low Value
Common reed	*Phragmites australis*	06/01/11	63	63	APG-24	Aquablok	Low Value
Rice cutgrass	*Leersia oryzoides*	06/01/11	10.5	3	APG-24	Aquablok	Low Value
Arrow arum	*Peltandra virginica*	06/01/11	3	3	APG-3	Sand Control	Low Value
Blue flag iris	*Iris versicolor*	06/01/11	3	0	APG-3	Sand Control	Low Value
Canada rush	*Juncus canadensis*	06/01/11	10.5	10.5	APG-3	Sand Control	Low Value
Fox sedge	*Carex stipata/vulpinoidea*	06/01/11	10.5	0	APG-3	Sand Control	Low Value
Lurid sedge	*Carex lurida*	06/01/11	3	0	APG-3	Sand Control	Low Value
Marsh bedstraw	*Galium palustre*	06/01/11	3	3	APG-3	Sand Control	Low Value
Marsh fern	*Thelypteris Thelypteroides*	06/01/11	0	3	APG-3	Sand Control	Low Value
Narrow-leaved cattail	*Typha angustifolia*	06/01/11	63	63	APG-3	Sand Control	Low Value
Poison ivy	*Toxiciodendron radicans*	06/01/11	0	3	APG-3	Sand Control	Low Value
Rice cutgrass	*Leersia oryzoides*	06/01/11	3	0	APG-3	Sand Control	Low Value
Rose mallow	*Hibiscus palustris*	06/01/11	10.5	10.5	APG-3	Sand Control	Low Value
Soft rush	*Juincus effusus*	06/01/11	10.5	0	APG-3	Sand Control	Low Value
Swamp rose	*Rosa palustris*	06/01/11	38	20.5	APG-3	Sand Control	Low Value
Virginia creeper	*Parthenoisus quinquefolia*	06/01/11	0	0.5	APG-3	Sand Control	Low Value
Water parsnip	*Sium suave*	06/01/11	0.5	0	APG-3	Sand Control	Low Value
Woolgrass	*Scirpus cyperinus*	06/01/11	3	0	APG-3	Sand Control	Low Value
Arrow arum	*Peltandra virginica*	06/01/11	85.5	63	APG-4	Control	Low Value
Canada rush	*Juncus canadensis*	06/01/11	63	38	APG-4	Control	Low Value
Narrow-leaved cattail	*Typha angustifolia*	06/01/11	0.5	0.5	APG-4	Control	Low Value
Water parsnip	*Sium suave*	06/01/11	0.5	0.5	APG-4	Control	Low Value
Wild rice	*Zizania aquatica*	06/01/11	38	38	APG-4	Control	Low Value
Arrow arum	*Peltandra virginica*	06/01/11	3	3	APG-5	Aquablok	Low Value
False nettle	*Boehmeria cylindrica*	06/01/11	3	0.5	APG-5	Aquablok	Low Value
Marsh fern	*Thelypteris Thelypteroides*	06/01/11	3	3	APG-5	Aquablok	Low Value
Narrow-leaved cattail	*Typha angustifolia*	06/01/11	85.5	98	APG-5	Aquablok	Low Value
Poison ivy	*Toxiciodendron radicans*	06/01/11	0.5	3	APG-5	Aquablok	Low Value
Rice cutgrass	*Leersia oryzoides*	06/01/11	0	3	APG-5	Aquablok	Low Value
Rose mallow	*Hibiscus palustris*	06/01/11	10.5	10.5	APG-5	Aquablok	Low Value
Sensitive fern	*Onoclea sensibilis*	06/01/11	38	10.5	APG-5	Aquablok	Low Value
Water hemlock	*Cicuta maculata*	06/01/11	20.5	0.5	APG-5	Aquablok	Low Value
Arrow arum	*Peltandra virginica*	06/01/11	38	38	APG-6	Aquablok	Low Value
Canada rush	*Juncus canadensis*	06/01/11	38	20.5	APG-6	Aquablok	Low Value

Time One - June 2011

Common Name	Latin Name	Date	Cover Class 4m Circle Plot	Cover Class 2X5m Plot	Plot ID	Treatment	Wetland Quality
Narrow-leaved cattail	*Typha angustifolia*	06/01/11	63	63	APG-6	Aquablok	Low Value
Rice cutgrass	*Leersia oryzoides*	06/01/11	10.5	10.5	APG-6	Aquablok	Low Value
Rose mallow	*Hibiscus palustris*	06/01/11	0.5	0	APG-6	Aquablok	Low Value
Water parsnip	*Sium suave*	06/01/11	0	3	APG-6	Aquablok	Low Value
Arrow arum	*Peltandra virginica*	06/01/11	10.5	38	APG-7	Control	Low Value
Canada rush	*Juncus canadensis*	06/01/11	0	0.5	APG-7	Control	Low Value
Elderberry	*Sambucus canadensis*	06/01/11	3	0	APG-7	Control	Low Value
False nettle	*Boehmeria cylindrica*	06/01/11	10.5	0.5	APG-7	Control	Low Value
Halberd-leaved tearthumb	*Polygonum arifolium*	06/01/11	10.5	0.5	APG-7	Control	Low Value
Jewelweed	*Impatiens capensis*	06/01/11	0.5	3	APG-7	Control	Low Value
Marsh fern	*Thelypteris Thelypteroides*	06/01/11	0.5	0.5	APG-7	Control	Low Value
Narrow-leaved cattail	*Typha angustifolia*	06/01/11	85.5	63	APG-7	Control	Low Value
Poison ivy	*Toxiciodendron radicans*	06/01/11	3	0	APG-7	Control	Low Value
Rice cutgrass	*Leersia oryzoides*	06/01/11	3	3	APG-7	Control	Low Value
Rose mallow	*Hibiscus palustris*	06/01/11	20.5	10.5	APG-7	Control	Low Value
Virginia creeper	*Parthenoisus quinquefolia*	06/01/11	3	0	APG-7	Control	Low Value
Water hemlock	*Cicuta maculata*	06/01/11	3	3	APG-7	Control	Low Value
Arrow arum	*Peltandra virginica*	06/01/11	38	63	APG-8	Slurry Spray	Low Value
Canada rush	*Juncus canadensis*	06/01/11	0.5	20.5	APG-8	Slurry Spray	Low Value
Fox sedge	*Carex stipata/vulpinoidea*	06/01/11	0.5	0.5	APG-8	Slurry Spray	Low Value
Marsh fern	*Thelypteris Thelypteroides*	06/01/11	20.5	0.5	APG-8	Slurry Spray	Low Value
Narrow-leaved cattail	*Typha angustifolia*	06/01/11	85.5	38	APG-8	Slurry Spray	Low Value
Rice cutgrass	*Leersia oryzoides*	06/01/11	20.5	38	APG-8	Slurry Spray	Low Value
Rose mallow	*Hibiscus palustris*	06/01/11	10.5	10.5	APG-8	Slurry Spray	Low Value
Silky dogwood	*Cornus amomum*	06/01/11	0.5	0	APG-8	Slurry Spray	Low Value
Soft rush	*Juncus effusus*	06/01/11	3	0	APG-8	Slurry Spray	Low Value
Soft-stem bulrush	*Scirpus validus*	06/01/11	0	10.5	APG-8	Slurry Spray	Low Value
Water hemlock	*Cicuta maculata*	06/01/11	3	0	APG-8	Slurry Spray	Low Value
Arrow arum	*Peltandra virginica*	06/01/11	20.5	98	APG-9	Aquablok	Low Value
Bladderwort	*Utricularia sp.*	06/01/11	0.5	0	APG-9	Aquablok	Low Value
Canada rush	*Juncus canadensis*	06/01/11	63	10.5	APG-9	Aquablok	Low Value
Narrow-leaved cattail	*Typha angustifolia*	06/01/11	3	3	APG-9	Aquablok	Low Value
Rice cutgrass	*Leersia oryzoides*	06/01/11	10.5	0	APG-9	Aquablok	Low Value
Water parsnip	*Sium suave*	06/01/11	0.5	0	APG-9	Aquablok	Low Value
Wild rice	*Zizania aquatica*	06/01/11	20.5	38	APG-9	Aquablok	Low Value

Modified Daubenmire cover class system

Cover Classes

<1	0.5
1-5	3.0
6-15	10.5
16-25	20.5
26-50	38.0
51-75	63.0
76-95	85.5
96-100	98.0

ATTACHMENT B
VEGETATION DATA

Time Two - October 2011

Common Name	Latin Name	Date	Cover Class 4m Circle Plot	Cover Class 2X5m Plot	Plot ID	Treatment	Wetland Quality
Arrow Arum	*Peltandra virginica*	10/02/11	3	3	APG-1	Sand Control	Low Value
Arrow-leaved Tearthumb	*Polygonum sagittatum*	10/02/11	0.5	3	APG-1	Sand Control	Low Value
Buttonbush	*Cephalanthus occidentalis*	10/02/11	0.5	0	APG-1	Sand Control	Low Value
Canada rush	*Juncus canadensis*	10/02/11	0	3	APG-1	Sand Control	Low Value
Common reed	*Phragmites australis*	10/02/11	20.5	20.5	APG-1	Sand Control	Low Value
Marsh Bedstraw	*Galium palustre*	10/02/11	0	3	APG-1	Sand Control	Low Value
Narrow-Leaved Cattail	*Typha angustifolia*	10/02/11	63	85.5	APG-1	Sand Control	Low Value
Nodding Bur-Marigold	*Bidens cernua*	10/02/11	0	0.5	APG-1	Sand Control	Low Value
Rice cutgrass	*Leersia oryzoides*	10/02/11	3	20.5	APG-1	Sand Control	Low Value
Rose mallow	*Hibiscus palustris*	10/02/11	10.5	10.5	APG-1	Sand Control	Low Value
Water Smartweed	*Polygonum punctatum*	10/02/11	3	3	APG-1	Sand Control	Low Value
Woolgrass	*Scirpus cyperinus*	10/02/11	3	0	APG-1	Sand Control	Low Value
Arrow arum	*Peltandra virginica*	10/02/11	10.5	38	APG-10	Sand Control	High Value
Canada rush	*Juncus canadensis*	10/02/11	20.5	3	APG-10	Sand Control	High Value
Common reed	*Phragmites australis*	10/02/11	63	0	APG-10	Sand Control	High Value
Halberd-leaved tearthumb	*Polygonum arifolium*	10/02/11	3	0	APG-10	Sand Control	High Value
Marsh bedstraw	*Galium palustre*	10/02/11	0	3	APG-10	Sand Control	High Value
Rice cutgrass	*Leersia oryzoides*	10/02/11	3	10.5	APG-10	Sand Control	High Value
Water Smartweed	*Polygonum punctatum*	10/02/11	10.5	20.5	APG-10	Sand Control	High Value
Wild rice	*Zizania aquatica*	10/02/11	10.5	63	APG-10	Sand Control	High Value
Arrow arum	*Peltandra virginica*	10/02/11	38	20.5	APG-11	Aquablok	High Value
Aster	*Aster sp.*	10/02/11	3	3	APG-11	Aquablok	High Value
Canada rush	*Juncus canadensis*	10/02/11	10.5	0.5	APG-11	Aquablok	High Value
Common reed	*Phragmites australis*	10/02/11	20.5	10.5	APG-11	Aquablok	High Value
Fox grape	*Vitis labrusca*	10/02/11	0	10.5	APG-11	Aquablok	High Value
Narrow-leaved cattail	*Typha angustifolia*	10/02/11	3	63	APG-11	Aquablok	High Value
Rice cutgrass	*Leersia oryzoides*	10/02/11	38	3	APG-11	Aquablok	High Value
Rose mallow	*Hibiscus palustris*	10/02/11	3	3	APG-11	Aquablok	High Value
Water parsnip	*Sium suave*	10/02/11	0.5	3	APG-11	Aquablok	High Value
Water Smartweed	*Polygonum punctatum*	10/02/11	20.5	0	APG-11	Aquablok	High Value
Whorled coreopsis	*Coreopsis verticillata*	10/02/11	10.5	0.5	APG-11	Aquablok	High Value
Wild rice	*Zizania aquatica*	10/02/11	38	3	APG-11	Aquablok	High Value
Arrow arum	*Peltandra virginica*	10/02/11	20.5	10.5	APG-12	Control	High Value
Canada rush	*Juncus canadensis*	10/02/11	38	38	APG-12	Control	High Value
Common reed	*Phragmites australis*	10/02/11	0.5	0	APG-12	Control	High Value
Narrow-leaved cattail	*Typha angustifolia*	10/02/11	0.5	0.5	APG-12	Control	High Value
Rose mallow	*Hibiscus palustris*	10/02/11	20.5	3	APG-12	Control	High Value
Water Smartweed	*Polygonum punctatum*	10/02/11	10.5	3	APG-12	Control	High Value
Wild rice	*Zizania aquatica*	10/02/11	38	38	APG-12	Control	High Value
Arrow arum	*Peltandra virginica*	10/02/11	20.5	20.5	APG-13	Aquablok	High Value
Canada rush	*Juncus canadensis*	10/02/11	38	10.5	APG-13	Aquablok	High Value
Narrow-leaved cattail	*Typha angustifolia*	10/02/11	3	0	APG-13	Aquablok	High Value
Rice cutgrass	*Leersia oryzoides*	10/02/11	10.5	0	APG-13	Aquablok	High Value
Water Smartweed	*Polygonum punctatum*	10/02/11	20.5	20.5	APG-13	Aquablok	High Value
Wild rice	*Zizania aquatica*	10/02/11	63	63	APG-13	Aquablok	High Value
Arrow arum	*Peltandra virginica*	10/02/11	38	10.5	APG-14	Sand Control	High Value
Bladderwort	*Utricularia sp.*	10/02/11	3	3	APG-14	Sand Control	High Value
Canada rush	*Juncus canadensis*	10/02/11	0.5	20.5	APG-14	Sand Control	High Value
Narrow-leaved cattail	*Typha angustifolia*	10/02/11	3	10.5	APG-14	Sand Control	High Value
Rice cutgrass	*Leersia oryzoides*	10/02/11	0	3	APG-14	Sand Control	High Value
Water Smartweed	*Polygonum punctatum*	10/02/11	10.5	3	APG-14	Sand Control	High Value
Wild rice	*Zizania aquatica*	10/02/11	85.5	38	APG-14	Sand Control	High Value
Arrow arum	*Peltandra virginica*	10/02/11	38	38	APG-15	Control	High Value
Canada rush	*Juncus canadensis*	10/02/11	63	20.5	APG-15	Control	High Value
Climbing boneset	*Mikania scandens*	10/02/11	3	3	APG-15	Control	High Value
Common reed	*Phragmites australis*	10/02/11	0.5	0	APG-15	Control	High Value
Narrow-leaved cattail	*Typha angustifolia*	10/02/11	0.5	0	APG-15	Control	High Value
Pickerelweed	*Pontederia cordata*	10/02/11	10.5	0.5	APG-15	Control	High Value
Rice cutgrass	*Leersia oryzoides*	10/02/11	3	20.5	APG-15	Control	High Value
Swamp candles	*Lysimachia terrestris*	10/02/11	0.5	0	APG-15	Control	High Value
Water Smartweed	*Polygonum punctatum*	10/02/11	10.5	3	APG-15	Control	High Value
Wild rice	*Zizania aquatica*	10/02/11	85.5	85.5	APG-15	Control	High Value
Arrow arum	*Peltandra virginica*	10/02/11	85.5	85.5	APG-16	SediMite	High Value
Canada rush	*Juncus canadensis*	10/02/11	0.5	3	APG-16	SediMite	High Value
Common reed	*Phragmites australis*	10/02/11	10.5	0	APG-16	SediMite	High Value
Wild rice	*Zizania aquatica*	10/02/11	38	20.5	APG-16	SediMite	High Value
Arrow arum	*Peltandra virginica*	10/02/11	38	63	APG-17	SediMite	High Value

Time Two - October 2011

Common Name	Latin Name	Date	Cover Class 4m Circle Plot	Cover Class 2X5m Plot	Plot ID	Treatment	Wetland Quality
Canada rush	*Juncus canadensis*	10/02/11	85.5	10.5	APG-17	SediMite	High Value
Narrow-leaved cattail	*Typha angustifolia*	10/02/11	0.5	0	APG-17	SediMite	High Value
Rice cutgrass	*Leersia oryzoides*	10/02/11	3	0	APG-17	SediMite	High Value
Wild rice	*Zizania aquatica*	10/02/11	38	38	APG-17	SediMite	High Value
Arrow arum	*Peltandra virginica*	10/02/11	63	38	APG-18	SediMite	High Value
Common reed	*Phragmites australis*	10/02/11	3	0.5	APG-18	SediMite	High Value
Pickerelweed	*Pontederia cordata*	10/02/11	3	0	APG-18	SediMite	High Value
Wild rice	*Zizania aquatica*	10/02/11	20.5	10.5	APG-18	SediMite	High Value
Arrow arum	*Peltandra virginica*	10/02/11	20.5	38	APG-19	SediMite	High Value
Bur reed	*Sparganium sp.*	10/02/11	3	0	APG-19	SediMite	High Value
Canada rush	*Juncus canadensis*	10/02/11	63	38	APG-19	SediMite	High Value
Common reed	*Phragmites australis*	10/02/11	0.5	0	APG-19	SediMite	High Value
Narrow-leaved cattail	*Typha angustifolia*	10/02/11	20.5	0	APG-19	SediMite	High Value
Pickerelweed	*Pontederia cordata*	10/02/11	10.5	10.5	APG-19	SediMite	High Value
Soft-stem bulrush	*Scirpus validus*	10/02/11	0.5	0.5	APG-19	SediMite	High Value
Wild rice	*Zizania aquatica*	10/02/11	20.5	63	APG-19	SediMite	High Value
Arrow Arum	*Peltandra virginica*	10/02/11	3	0.5	APG-2	Slurry Spray	Low Value
Arrow-leaved tearthumb	*Polygonum sagittatum*	10/02/11	0	3	APG-2	Slurry Spray	Low Value
Canada rush	*Juncus canadensis*	10/02/11	20.5	38	APG-2	Slurry Spray	Low Value
Climbing boneset	*Mikania scandens*	10/02/11	0	10.5	APG-2	Slurry Spray	Low Value
False nettle	*Boehmeria cylindrica*	10/02/11	3	10.5	APG-2	Slurry Spray	Low Value
Halberd-leaved tearthumb	*Polygonum arifolium*	10/02/11	0.5	0	APG-2	Slurry Spray	Low Value
Marsh Bedstraw	*Galium palustre*	10/02/11	20.5	63	APG-2	Slurry Spray	Low Value
Narrow-Leaved Cattail	*Typha angustifolia*	10/02/11	85.5	85.5	APG-2	Slurry Spray	Low Value
Rice cutgrass	*Leersia oryzoides*	10/02/11	20.5	20.5	APG-2	Slurry Spray	Low Value
Rose Mallow	*Hibiscus palustris*	10/02/11	3	3	APG-2	Slurry Spray	Low Value
Arrow arum	*Peltandra virginica*	10/02/11	10.5	3	APG-20	Aquablok	High Value
Arrow-leaved tearthumb	*Polygonum sagittatum*	10/02/11	0.5	0	APG-20	Aquablok	High Value
Canada rush	*Juncus canadensis*	10/02/11	98	3	APG-20	Aquablok	High Value
Climbing boneset	*Mikania scandens*	10/02/11	0	10.5	APG-20	Aquablok	High Value
Common reed	*Phragmites australis*	10/02/11	0	10.5	APG-20	Aquablok	High Value
False nettle	*Boehmeria cylindrica*	10/02/11	3	3	APG-20	Aquablok	High Value
Lurid Sedge	*Carex lurida*	10/02/11	0.5	0	APG-20	Aquablok	High Value
Narrow-leaved cattail	*Typha angustifolia*	10/02/11	3	38	APG-20	Aquablok	High Value
Rice cutgrass	*Leersia oryzoides*	10/02/11	20.5	38	APG-20	Aquablok	High Value
Rose mallow	*Hibiscus palustris*	10/02/11	3	0	APG-20	Aquablok	High Value
Water horehound	*Lycopus americanus*	10/02/11	3	0	APG-20	Aquablok	High Value
Whorled coreopsis	*Coreopsis verticillata*	10/02/11	0	3	APG-20	Aquablok	High Value
Wild rice	*Zizania aquatica*	10/02/11	0	10.5	APG-20	Aquablok	High Value
Climbing boneset	*Mikania scandens*	10/02/11	0.5	0.5	APG-21	Aquablok	High Value
Common reed	*Phragmites australis*	10/02/11	98	98	APG-21	Aquablok	High Value
Water Smartweed	*Polygonum punctatum*	10/02/11	0.5	0.5	APG-21	Aquablok	High Value
Arrow arum	*Peltandra virginica*	10/02/11	3	0.5	APG-22	Slurry Spray	Low Value
Common reed	*Phragmites australis*	10/02/11	85.5	63	APG-22	Slurry Spray	Low Value
Rice cutgrass	*Leersia oryzoides*	10/02/11	10.5	3	APG-22	Slurry Spray	Low Value
Rose mallow	*Hibiscus palustris*	10/02/11	3	0	APG-22	Slurry Spray	Low Value
Water parsnip	*Sium suave*	10/02/11	0	0.5	APG-22	Slurry Spray	Low Value
Arrow arum	*Peltandra virginica*	10/02/11	3	0.5	APG-23	Slurry Spray	Low Value
Climbing boneset	*Mikania scandens*	10/02/11	3	3	APG-23	Slurry Spray	Low Value
Common reed	*Phragmites australis*	10/02/11	98	85.5	APG-23	Slurry Spray	Low Value
Swamp milkweed	*Asclepias incarnata*	10/02/11	0	0.5	APG-23	Slurry Spray	Low Value
Arrow arum	*Peltandra virginica*	10/02/11	0.5	3	APG-24	Aquablok	Low Value
Black gum	*Nyssa sylvatica*	10/02/11	3	0	APG-24	Aquablok	Low Value
Common reed	*Phragmites australis*	10/02/11	63	63	APG-24	Aquablok	Low Value
Rice cutgrass	*Leersia oryzoides*	10/02/11	0.5	0	APG-24	Aquablok	Low Value
Rose mallow	*Hibiscus palustris*	10/02/11	0	3	APG-24	Aquablok	Low Value
Wild rice	*Zizania aquatica*	10/02/11	3	3	APG-24	Aquablok	Low Value
Arrow arum	*Peltandra virginica*	10/02/11	3	0.5	APG-3	Sand Control	Low Value
Blue flag iris	*Iris versicolor*	10/02/11	3	0	APG-3	Sand Control	Low Value
Canada rush	*Juncus canadensis*	10/02/11	10.5	10.5	APG-3	Sand Control	Low Value
False nettle	*Boehmeria cylindrica*	10/02/11	3	10.5	APG-3	Sand Control	Low Value
Fox grape	*Vitis labrusca*	10/02/11	10.5	0	APG-3	Sand Control	Low Value
Halberd-leaved tearthumb	*Polygonum arifolium*	10/02/11	10.5	0	APG-3	Sand Control	Low Value
Marsh bedstraw	*Galium palustre*	10/02/11	3	3	APG-3	Sand Control	Low Value
Marsh fern	*Thelypteris Thelypteroides*	10/02/11	0	10.5	APG-3	Sand Control	Low Value
Narrow-leaved cattail	*Typha angustifolia*	10/02/11	63	63	APG-3	Sand Control	Low Value
Nodding Bur-Marigold	*Bidens cernua*	10/02/11	3	0	APG-3	Sand Control	Low Value

ATTACHMENT B
VEGETATION DATA

Time Two - October 2011

Common Name	Latin Name	Date	Cover Class 4m Circle Plot	Cover Class 2X5m Plot	Plot ID	Treatment	Wetland Quality
Poison ivy	*Toxiciodendron radicans*	10/02/11	0	3	APG-3	Sand Control	Low Value
Rice cutgrass	*Leersia oryzoides*	10/02/11	10.5	3	APG-3	Sand Control	Low Value
Rose mallow	*Hibiscus palustris*	10/02/11	10.5	10.5	APG-3	Sand Control	Low Value
Soft rush	*Juincus effusus*	10/02/11	10.5	0	APG-3	Sand Control	Low Value
Swamp candles	*Lysimachia terrestris*	10/02/11	3	0	APG-3	Sand Control	Low Value
Swamp rose	*Rosa palustris*	10/02/11	38	20.5	APG-3	Sand Control	Low Value
Virginia creeper	*Parthenoisus quinquefolia*	10/02/11	0	0.5	APG-3	Sand Control	Low Value
Water parsnip	*Sium suave*	10/02/11	0.5	0	APG-3	Sand Control	Low Value
Woolgrass	*Scirpus cyperinus*	10/02/11	3	0	APG-3	Sand Control	Low Value
Arrow arum	*Peltandra virginica*	10/02/11	38	20.5	APG-4	Control	Low Value
Canada rush	*Juncus canadensis*	10/02/11	63	38	APG-4	Control	Low Value
Common reed	*Phragmites australis*	10/02/11	0	0.5	APG-4	Control	Low Value
Halberd-leaved tearthumb	*Polygonum arifolium*	10/02/11	0.5	0.5	APG-4	Control	Low Value
Narrow-leaved cattail	*Typha angustifolia*	10/02/11	0.5	0.5	APG-4	Control	Low Value
Rice cutgrass	*Leersia oryzoides*	10/02/11	3	0	APG-4	Control	Low Value
Water Smartweed	*Polygonum punctatum*	10/02/11	0.5	0.5	APG-4	Control	Low Value
Wild rice	*Zizania aquatica*	10/02/11	63	20.5	APG-4	Control	Low Value
Arrow arum	*Peltandra virginica*	10/02/11	0.5	3	APG-5	Aquablok	Low Value
Canada rush	*Juncus canadensis*	10/02/11	0	3	APG-5	Aquablok	Low Value
False nettle	*Boehmeria cylindrica*	10/02/11	3	3	APG-5	Aquablok	Low Value
Halberd-leaved tearthumb	*Polygonum arifolium*	10/02/11	0.5	0	APG-5	Aquablok	Low Value
Marsh fern	*Thelypteris Thelypteroides*	10/02/11	10.5	10.5	APG-5	Aquablok	Low Value
Narrow-leaved cattail	*Typha angustifolia*	10/02/11	85.5	98	APG-5	Aquablok	Low Value
Poison ivy	*Toxiciodendron radicans*	10/02/11	0.5	3	APG-5	Aquablok	Low Value
Rice cutgrass	*Leersia oryzoides*	10/02/11	0	10.5	APG-5	Aquablok	Low Value
Rose mallow	*Hibiscus palustris*	10/02/11	10.5	10.5	APG-5	Aquablok	Low Value
Sensitive fern	*Onoclea sensibilis*	10/02/11	20.5	3	APG-5	Aquablok	Low Value
Water hemlock	*Cicuta maculata*	10/02/11	3	0	APG-5	Aquablok	Low Value
Water Smartweed	*Polygonum punctatum*	10/02/11	0	0.5	APG-5	Aquablok	Low Value
Arrow arum	*Peltandra virginica*	10/02/11	10.5	10.5	APG-6	Aquablok	Low Value
Canada rush	*Juncus canadensis*	10/02/11	38	20.5	APG-6	Aquablok	Low Value
Climbing boneset	*Mikania scandens*	10/02/11	0	3	APG-6	Aquablok	Low Value
False nettle	*Boehmeria cylindrica*	10/02/11	3	0	APG-6	Aquablok	Low Value
Marsh bedstraw	*Galium palustre*	10/02/11	0.5	3	APG-6	Aquablok	Low Value
Narrow-leaved cattail	*Typha angustifolia*	10/02/11	63	63	APG-6	Aquablok	Low Value
Rice cutgrass	*Leersia oryzoides*	10/02/11	20.5	10.5	APG-6	Aquablok	Low Value
Rose mallow	*Hibiscus palustris*	10/02/11	10.5	0	APG-6	Aquablok	Low Value
Water parsnip	*Sium suave*	10/02/11	0	3	APG-6	Aquablok	Low Value
Water Smartweed	*Polygonum punctatum*	10/02/11	0	0.5	APG-6	Aquablok	Low Value
Whorled coreopsis	*Coreopsis verticillata*	10/02/11	0.5	0	APG-6	Aquablok	Low Value
Wild rice	*Zizania aquatica*	10/02/11	10.5	10.5	APG-6	Aquablok	Low Value
Arrow arum	*Peltandra virginica*	10/02/11	0.5	10.5	APG-7	Control	Low Value
Climbing boneset	*Mikania scandens*	10/02/11	3	3	APG-7	Control	Low Value
Elderberry	*Sambucus canadensis*	10/02/11	3	0	APG-7	Control	Low Value
False nettle	*Boehmeria cylindrica*	10/02/11	20.5	10.5	APG-7	Control	Low Value
Halberd-leaved tearthumb	*Polygonum arifolium*	10/02/11	10.5	0.5	APG-7	Control	Low Value
Marsh fern	*Thelypteris Thelypteroides*	10/02/11	10.5	10.5	APG-7	Control	Low Value
Narrow-leaved cattail	*Typha angustifolia*	10/02/11	85.5	63	APG-7	Control	Low Value
Poison ivy	*Toxiciodendron radicans*	10/02/11	3	0	APG-7	Control	Low Value
Rice cutgrass	*Leersia oryzoides*	10/02/11	20.5	20.5	APG-7	Control	Low Value
Rose mallow	*Hibiscus palustris*	10/02/11	20.5	10.5	APG-7	Control	Low Value
Virginia creeper	*Parthenoisus quinquefolia*	10/02/11	3	0	APG-7	Control	Low Value
Water hemlock	*Cicuta maculata*	10/02/11	0	3	APG-7	Control	Low Value
Whorled coreopsis	*Coreopsis verticillata*	10/02/11	0.5	10.5	APG-7	Control	Low Value
Arrow arum	*Peltandra virginica*	10/02/11	3	10.5	APG-8	Slurry Spray	Low Value
Arrow-leaved tearthumb	*Polygonum sagittatum*	10/02/11	3	0	APG-8	Slurry Spray	Low Value
Canada rush	*Juncus canadensis*	10/02/11	0	20.5	APG-8	Slurry Spray	Low Value
Climbing boneset	*Mikania scandens*	10/02/11	3	0	APG-8	Slurry Spray	Low Value
Marsh fern	*Thelypteris Thelypteroides*	10/02/11	38	3	APG-8	Slurry Spray	Low Value
Narrow-leaved cattail	*Typha angustifolia*	10/02/11	85.5	38	APG-8	Slurry Spray	Low Value
Rice cutgrass	*Leersia oryzoides*	10/02/11	63	63	APG-8	Slurry Spray	Low Value
Rose mallow	*Hibiscus palustris*	10/02/11	10.5	20.5	APG-8	Slurry Spray	Low Value
Soft rush	*Juncus effusus*	10/02/11	3	0	APG-8	Slurry Spray	Low Value
Soft-stem bulrush	*Scirpus validus*	10/02/11	0	3	APG-8	Slurry Spray	Low Value
Water hemlock	*Cicuta maculata*	10/02/11	0.5	0.5	APG-8	Slurry Spray	Low Value
Whorled coreopsis	*Coreopsis verticillata*	10/02/11	0.5	0	APG-8	Slurry Spray	Low Value
Arrow arum	*Peltandra virginica*	10/02/11	3	3	APG-9	Aquablok	Low Value

Time Two - October 2011

Common Name	Latin Name	Date	Cover Class 4m Circle Plot	Cover Class 2X5m Plot	Plot ID	Treatment	Wetland Quality
Bladderwort	*Utricularia sp.*	10/02/11	0.5	0	APG-9	Aquablok	Low Value
Bur reed	*Sparganium sp.*	10/02/11	0	3	APG-9	Aquablok	Low Value
Canada rush	*Juncus canadensis*	10/02/11	63	10.5	APG-9	Aquablok	Low Value
Narrow-leaved cattail	*Typha angustifolia*	10/02/11	10.5	10.5	APG-9	Aquablok	Low Value
Pickerelweed	*Pontederia cordata*	10/02/11	10.5	0.5	APG-9	Aquablok	Low Value
Rice cutgrass	*Leersia oryzoides*	10/02/11	38	10.5	APG-9	Aquablok	Low Value
Water parsnip	*Sium suave*	10/02/11	0.5	0	APG-9	Aquablok	Low Value
Water Smartweed	*Polygonum punctatum*	10/02/11	3	3	APG-9	Aquablok	Low Value
Wild rice	*Zizania aquatica*	10/02/11	63	85.5	APG-9	Aquablok	Low Value

Modified Daubenmire cover class system

Cover Classes

<1	0.5
1-5	3.0
6-15	10.5
16-25	20.5
26-50	38.0
51-75	63.0
76-95	85.5
96-100	98.0

ATTACHMENT B
SUMMARY OF VEGETATION METRICS

		Time Zero - November 2009 4m Circle Plot			Time One - June 2011 4m Circle Plot			Time Two - October 2011 4m Circle Plot		
Plot ID	**Treatment**	**Shannon-Wiener Diversity Index**	**Species Richness**	**Relative Cover (%)**	**Shannon-Wiener Diversity Index**	**Species Richness**	**Relative Cover (%)**	**Shannon-Wiener Diversity Index**	**Species Richness**	**Relative Cover (%)**
APG-1	Sand Control	1.408927298	7	111	1.222376316	5	132.5	1.307260251	9	107
APG-10	Sand Control	1.945910149	7	73.5	1.200392982	6	128	1.460284824	7	121
APG-11	Aquablok	1.487431919	6	95.5	1.48098736	8	121.5	2.002342969	11	185.5
APG-12	Control	1.602189485	6	58	1.037892037	5	87.5	1.554059165	7	128.5
APG-13	Aquablok	1.523878298	6	83	1.250555298	5	160	1.502797119	6	155.5
APG-14	Sand Control	0.410116318	2	73.5	0.905482829	5	107.5	1.034097421	6	140.5
APG-15	Control	1.473205703	5	125	1.284846504	7	161	1.489127585	10	215
APG-16	SediMite	0.287488438	3	91.5	0.486340397	5	112.5	0.864989546	4	134.5
APG-17	SediMite	0.73562194	3	84	0.931821494	4	137	1.107436616	5	165
APG-18	SediMite	0.9756076	3	69	0.48585501	3	119	0.812362964	4	89.5
APG-19	SediMite	1.200315001	5	92.5	1.396686604	8	139	1.523928982	8	139
APG-2	Slurry Spray	1.340081738	5	207.5	1.355095815	6	168	1.374811808	8	156.5
APG-20	Aquablok	1.606515287	9	144.5	0.983113937	9	134.5	1.093678018	9	142
APG-21	Aquablok	0	1	100	0.194291415	4	102	0.063466661	3	99
APG-22	Slurry Spray	0	1	100	0.942413281	5	122.5	0.589391793	4	102
APG-23	Slurry Spray	0	1	100	0.133708143	2	101	0.260559297	3	104
APG-24	Aquablok	0.148042247	2	88.5	0.86025059	4	87	0.435409323	5	70
APG-3	Sand Control	1.409109344	10	135	1.880592014	13	161.5	2.149703467	16	185.5
APG-4	Control	0.907535294	3	16.5	1.079641433	5	187.5	1.195070078	7	168.5
APG-5	Aquablok	1.126974888	5	172.5	1.351540138	8	164	1.204927071	9	134.5
APG-6	Aquablok	1.467853451	7	173.5	1.265189277	5	150	1.630542097	9	157
APG-7	Control	0.809715136	6	108	1.567112827	12	153.5	1.729030947	12	181
APG-8	Slurry Spray	1.017602986	3	161.5	1.520968049	10	182.5	1.457709662	10	210
APG-9	Aquablok	1.772704799	8	56.5	1.296878885	7	118.5	1.530721119	9	192

ATTACHMENT B
SUMMARY OF VEGETATION METRICS

		Time One - June 2011 2x5m Plots			Time Two - October 2011 2x5m Plots		
Plot ID	Treatment	Shannon-Wiener Diversity Index	Species Richness	Relative Cover (%)	Shannon-Wiener Diversity Index	Species Richness	Relative Cover (%)
APG-1	Sand Control	1.403471624	9	169.5	1.453344128	12	152.5
APG-10	Sand Control	0.702292722	6	105	1.35880741	8	138
APG-11	Aquablok	1.005588382	8	110.5	1.570893608	12	120.5
APG-12	Control	0.798241284	6	117.5	1.227318972	7	93
APG-13	Aquablok	0.9756076	5	69	1.163768288	6	114.5
APG-14	Sand Control	1.264331754	5	102.5	1.551777973	7	88.5
APG-15	Control	1.086363355	7	104.5	1.348336395	10	171
APG-16	SediMite	0.164136866	5	101.5	0.603616715	5	109
APG-17	SediMite	0.588319348	5	119	0.911915156	5	111.5
APG-18	SediMite	0.373339107	4	109.5	0.574041917	4	49
APG-19	SediMite	1.261340717	8	200	1.265189277	8	150
APG-2	Slurry Spray	1.422426029	8	211.5	1.631713146	10	234.5
APG-20	Aquablok	1.369930044	10	110	1.739732972	13	119.5
APG-21	Aquablok	0.03188153	4	98.5	0.063466661	3	99
APG-22	Slurry Spray	0.732626283	6	80	0.22777712	5	67
APG-23	Slurry Spray	0.345206625	2	96	0.215458292	4	89.5
APG-24	Aquablok	0.773798604	4	104	0.514096697	6	72
APG-3	Sand Control	1.470277762	16	117	1.728984023	19	135.5
APG-4	Control	1.107493217	5	140	1.176184957	8	81
APG-5	Aquablok	1.010105759	9	132	1.255852748	12	145
APG-6	Aquablok	1.281943304	6	135	1.116172076	12	124.5
APG-7	Control	1.27801782	13	122.5	1.783001655	13	142.5
APG-8	Slurry Spray	1.630575327	11	181.5	1.58451601	12	159
APG-9	Aquablok	0.889969543	7	149.5	1.172594816	10	126.5

Appendix F: Benthic Macroinvertebrate Report

Watershed Assessment Associates
Environmental Services / Biomonitoring / Invertebrate Taxonomy / Professional Training

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Schenectady, NY 12305
Telephone 518 346-0225
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www.rwaa.us

To: John A. Bleiler
AECOM
250 Apollo Drive
Chelmsford, MA 01824

Date: February 2012

Project: AECOM Project # 60133180.603

From: J. Kelly Nolan, Aquatic Biologist
Director, Environmental Services

Re: Aberdeen wetland benthic macroinvertebrates

OVERVIEW

As part of ESTCP Project ER-0825, 48 benthic core samples (24 collected 6/3/11 and 24 collected 10/5/11) from 2 distinct wetlands were analyzed by Watershed Assessment Associates (WAA) for macroinvertebrate composition. The objective of the study was to evaluate *in situ* wetland remediation technologies designed to sequester contaminants in wetlands without significantly impacting benthic macroinvertebrate community structure.

The study areas were a low quality *Phragmites* dominated system (low value wetland, or LVW) and a diverse high value freshwater marsh (high value wetland, or HVW). Each wetland type was evaluated for benthic macroinvertebrate community structure within 8' x 8' reference and treatment plots. Two distinct sequestering agent delivery methods (slurry and pelletized systems) were applied to each treatment plot. Replicate benthic macroinvertebrate samples were collected from each plot using a 3 inch diameter sediment coring device with 5-7 inches of substrate penetration. Three sets of samples were collected: one pretreatment and two post-treatment. Pre-treatment samples were lost due to inadequate preservation; the 2 post-treatment sample sets were sent to WAA for benthic macroinvertebrate sample processing including identification and enumeration. This report is based on the samples received and analyzed by WAA.

The four LVW station plots are:

- APG_02 Slurry Spray
- APG_03 Sand Control
- APG_06 Aquablok®
- APG_07 Control (untreated)

The four HVW station plots are:

- APG_13 Aquablok®
- APG_14 Sand Control
- APG_15 Control (untreated)
- APG_16 SediMite™

RESULTS

The twelve LVW replicate samples collected on 6/3/11 comprised a total of 8 individuals. Station APG_07, the control plot, was the only station with an organism in all three replicate samples, and each replicate contained only 2 individuals. There were no organisms in replicate samples from the other LVW stations, except for an individual macroinvertebrate present in replicate A of both stations APG_03 and APG_06 (Table I).

The twelve HVW replicate samples from 6/3/11 contained a total of 63 individuals. Only two replicates, from station APG_14, the sand control, were devoid of organisms. The majority of organisms (37 individuals) were present at the control station APG_15 (Table I).

The twelve LVW replicate samples from 10/5/11 comprised a total of 7 individuals. Three of these individuals were from replicate C of the control plot at station APG 07. There were no organisms in replicates A and B of station APG_07. All the other stations within the LVW had at least one individual in at least one replicate (Table II).

The twelve HVW replicate samples from 10/5/11 comprised a total of 12 individuals: stations APG_13, 14, & 15 each contained four organisms and station APG_16, the SediMite plot, contained no organisms (Table II).

DISCUSSION

Simple statistics comparing differences in diversity scores of replicate means between control and treatment plots were attempted and yielded little information for two reasons:

1. Given the objectives of the study it was imperative to evaluate benthic macroinvertebrate community structure of pretreatment sample plots to post treatment study plots. Statistical analyses such as basic significance tests or other analyses of variance could have been performed to identify differences in mean biological community metric scores and estimate the extent of those differences (i.e. before and after treatment) (Elliott 1971, Lyman Ott and Longnecker 2010). However, without pretreatment sample data there are no baseline conditions for comparison and therefore what change may or may not have occurred cannot be determined with certainty. While the post treatment control plot samples provide some information about untreated conditions, specifically when compared to reference plots, without pretreatment monitoring data from all test plots, the variability within the control and treatment plots cannot be accurately characterized.

2. The benthic macroinvertebrate community identified from each replicate sample plot is extremely small, making data analysis difficult. This is especially true when trying to compute multivariate statistical techniques using macroinvertebrate community data. The natural condition of the wetland sampled may be a barrier to growth and development of an abundance of benthic taxa. Chemical and physical factors such as anoxic sediments and reduced flows may be affecting community structure well beyond any effect from both site contaminants and remedial treatment applications. However, without pretreatment data limited characterization of the effects of natural environmental variation on community structure can be made.

We did investigate the use of other multivariate techniques however, but determined that methods such as Principal Components Analysis (PCA) will not provide any additional information on community response to application in this case. PCA is a method of factor analysis which, in the case of benthic science, serves as a method of data reduction when large sets of variables may be acting in a system to affect the distribution of a population of organisms. PCA then allows for the removal of redundant variables. PCA is primarily used when the objective of the investigation is to understand the underlying factors influencing the distribution of a population in space (Kachigan 1991); the underlying factors typically are water or sediment chemistry or physical habitat information.

Because of the inability to apply basic diversity and statistical methods, the results of the replicate samples were composited, creating a single sample representing each station for both the June and October sampling events. This increased the total number of taxa at each station (Tables III and IV). Bray Curtis similarity analysis and a similarity profile test (SIMPROF) were applied to the data, to define relationships of the faunal composition between the samples, using PRIMER-E software version 6. SIMPROF provides a series of similarity profile permutation tests run on biotic data which looks for statistically significant evidence of genuine clusters of samples which are *a priori* unstructured (e.g., single samples from each of a number of sites) (Clarke and Warwick 2001).

Bray-Curtis similarity was calculated on 4th-root transformed species abundance data to define relationships of the benthic macroinvertebrate composition among all plots (Clarke & Warwick 2001). The purpose of this transformation is to accentuate the effect of rare, in our case few, species. The intra-location resemblance was subjected to group-average linkage cluster analysis. The SIMPROF test was performed on a null hypothesis that a specific sub-cluster can be recreated by permuting the entry species and samples. The significant branch (SIMPROF, $p < 0.05$) was used as a prerequisite for defining the plots.

No significant difference of the benthic macroinvertebrate community structure of plot clusters was identified in either wetland type for the June or October samplings (Figure I). The difference in community structure of the control plots and other plots at each wetland in June was not significant, as determined by SIMPROF despite each control plot containing the majority of taxa.

Additionally, the total taxa richness and density of organisms was reduced in the October sampling at all stations. The loss of the family Chironomidae is likely related to seasonal changes and life history; the organisms had likely emerged as adults and their presence was probably in egg stage.

Additional sampling events during the summer months, when benthic macroinvertebrate larvae productivity is highest, may provide data to help differentiate any changes in the macroinvertebrate population due to treatment of the wetland plots.

References

Clarke, K.R. and Warwick, R.M. (2001). Changes in marine communities: an approach to statistical analysis and interpretation, 2nd edition, PRIMER-E: Plymouth.

Elliott, J.M. 1971. Some methods for the statistical analysis of samples of benthic invertebrates. Freshwater Biological Association, Scientific Publication No. 25.

Kachigan, S.K. 1991. Multivariate Statistical Analysis. Second Edition. Radius Press, NY. 303 pages.

Ott, R.L., and Longnecker, M. 2010. An introduction to statistical methods and data analysis. Sixth Edition. Brooks/Cole, Cengage Learning, Belmont CA. 1273 pages.

Table I June 3, 2011 replicate samples total taxa list.

Station	APG_02			APG_03			APG_06			APG_07			APG_13			APG_14			APG_15			APG_16		
Taxa Replicate	**A**	**B**	**C**	**A**	**B**	**C**	**A**	**B**	**C**	**A**	**B**	**C**	**A**	**B**	**C**	**A**	**B**	**C**	**A**	**B**	**C**	**A**	**B**	**C**
Ceratopogoninae	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	1	10	---	1	---	---
Cladopelma sp.	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	1	---	---	---	---	---
Cladotanytarsus sp.	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	3	---	---
Curculionidae	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	1	---
Desmopachria sp.	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	1	---	---	---	---	---
Dicrotendipes sp.	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	1	---	---	---	---	---
Gastropoda	---	---	---	---	---	---	---	---	---	---	1	---	---	---	---	---	---	---	---	---	---	---	---	---
Gyraulus sp.	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	1	---	---	---	---	---
Hyalella sp.	---	---	---	---	---	---	---	---	---	---	---	---	1	---	---	---	---	---	---	---	---	---	---	---
Limoniinae	---	---	---	---	---	---	1	---	---	1	---	---	3	---	---	---	---	---	3	2	1	---	---	6
Pisidiidae	---	---	---	1	---	---	---	---	---	1	1	2	4	---	1	---	---	4	7	6	1	---	---	---
Tanytarsus sp.	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	2	---	---	---	---	---
tubificoid Naididae w/o capilliform setae	---	---	---	---	---	---	---	---	---	---	---	---	---	2	---	---	---	---	---	---	---	---	---	---
Total individuals	0	0	0	1	0	0	1	0	0	2	2	2	8	2	1	0	0	4	17	18	2	4	1	6

Table II October 5, 2011 replicate samples total taxa list.

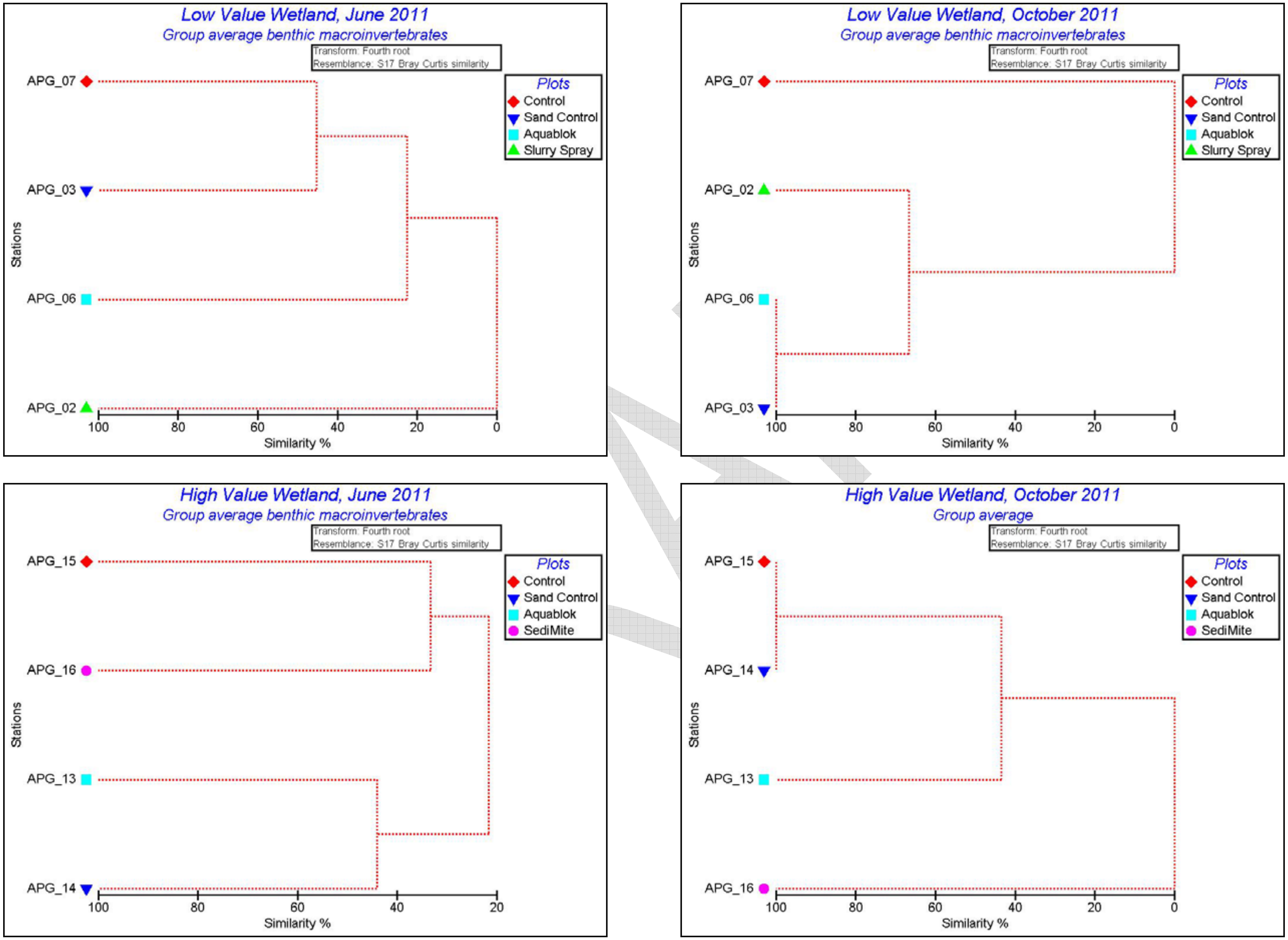
Station	APG_02			APG_03			APG_06			APG_07			APG_13			APG_14			APG_15			APG_16		
Taxa Replicate	**A**	**B**	**C**	**A**	**B**	**C**	**A**	**B**	**C**	**A**	**B**	**C**	**A**	**B**	**C**	**A**	**B**	**C**	**A**	**B**	**C**	**A**	**B**	**C**
Brachycera	---	---	---	---	---	---	---	---	---	---	---	3	---	---	---	---	---	---	---	---	---	---	---	---
Chrysops sp.	---	---	---	---	---	---	---	---	---	---	---	---	---	1	---	---	---	---	---	---	---	---	---	---
Limoniinae	---	---	1	1	---	---	---	---	1	---	---	---	---	1	---	3	1	---	---	3	1	---	---	---
Pisidiidae	---	---	---	---	---	---	---	---	---	---	---	---	---	2	---	---	---	---	---	---	---	---	---	---
Syrphidae	1	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
Total individuals	1	0	1	1	0	0	0	0	1	0	0	3	0	4	0	3	1	0	0	3	1	0	0	0

Table III June 3, 2011 composited sample taxa list.

Wetland Type	LVW	LVW	LVW	LVW	HVW	HVW	HVW	HVW
Plot application	Slurry Spray	Sand Control	Aquablok	Control	Aquablok	Sand Control	Control	SediMite
Taxa Station	APG_02	APG_03	APG_06	APG_07	APG_13	APG_14	APG_15	APG_16
Ceratopogoninae	--	--	--	--	--	--	11	1
Cladopelma sp.	--	--	--	--	--	--	1	--
Cladotanytarsus sp.	--	--	--	--	--	--	--	3
Curculionidae	--	--	--	--	--	--	--	1
Desmopachria sp.	--	--	--	--	--	--	1	--
Dicrotendipes sp.	--	--	--	--	--	--	1	--
Gastropoda	--	--	--	1	--	--	--	--
Gyraulus sp.	--	--	--	--	--	--	1	--
Hyalella sp.	--	--	--	--	1	--	--	--
Limoniinae	--	--	1	1	3	--	6	6
Pisidiidae	--	1	--	4	5	4	14	--
Tanytarsus sp.	--	--	--	--	--	--	2	--
tubificoid Naididae w/o capilliform setae	--	--	--	--	2	--	--	--
Total # Individuals	0	1	1	6	11	4	37	11

Table IV October 5, 2011 composited sample taxa list.

Wetland Type	LVW	LVW	LVW	LVW	HVW	HVW	HVW	HVW
Plot application	Slurry Spray	Sand Control	Aquablok	Control	Aquablok	Sand Control	Control	SediMite
Taxa Station	APG_02	APG_03	APG_06	APG_07	APG_13	APG_14	APG_15	APG_16
Brachycera	--	--	--	3	--	--	--	--
Chrysops sp.	--	--	--	--	1	--	--	--
Limoniinae	1	1	1	--	1	4	4	--
Pisidiidae	--	--	--	--	2	--	--	--
Syrphidae	1	--	--	--	--	--	--	--
Total # Individuals	2	1	1	3	4	4	4	0



Figures 1 Cluster analysis of benthic macroinvertebrate samples using the Bray-Curtis resemblance matrix-generated dendograms with significant relationships identified (dashed red lines) using the SIMPROF test.

Appendix G: Nutrient Study Report

Effects of Nutrient Uptake in Sediment on Survival, Growth, and Nutrient Uptake of *Echinochloa crusgalli* Seedlings

For

AECOM Environment
Chelmsford, MA, USA

AECOM

Prepared by

AECOM Technical Services, Inc.

Fort Collins Environmental Toxicology Lab

January 2013

60147216-445-(035-038)

AECOM

TABLE OF CONTENTS

LIST OF TABLES

LIST OF TABLES (cont.)

LIST OF FIGURES

AECOM

Report of Short-Term Toxicity of Whole Sediment to Echinochloa crusgalli

Project IDs: 60147216-445-(035-038)
September – December 2011

Sponsor and Laboratory Information

Sponsor	AECOM Environment 250 Apollo Drive Chelmsford, MA 01824
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Test Information

Test	Short-term chronic screening toxicity test of sediment	
Basis	Walsh (1991)	
Test Period	Control: October 14, 2011 @ 1300-1600 to December 30, 2011 @ 1345 (see text for additional information) Treatments: September 30, 2011 @ 1330-1600 to December 16, 2011 @ 0900	
Test Length	77 days	
Species	*Echinochloa crusgalli* (Japanese millet)	
Test Material	Whole sediment	
Sediment ID	Sample ID	FCETL Laboratory ID
	APG-06-MA-060311	25060
	APG-15-MA-060311	25061
	APG-02-MA-060311	25062
	APG-16-MA-060311	25063
Control Sediment	Artificial sediment	
Hydration water	Laboratory deionized water (Milli-Q®) on all test days Modified Gorsuch nutrient solution (Gorsuch et al. 2008) on specified test days.	
Test Concentrations	0 (control) and 100% of each test sediment	

- *Results described in this report apply only to the samples submitted to the laboratory and analyzed, as listed in the report*
- *Test results comply with NELAC standards. Reports are intended to be considered in their entirety; AECOM is not responsible for consequences arising from use of a partial report*
- *This report contains 28 pages plus 5 appendices*

INTRODUCTION

This report presents results for a study conducted to determine the differences in nutrient uptake in *Echinochloa crusgalli* seedlings grown in various sediment samples having undergone different treatments. This study included a control (laboratory sediment) and four sediment cores collected from different locations one core represents a site (reference) control, APG-15.

E. crusgalli seedlings were exposed to sediment samples provided by the client (Table 1). Seedlings were planted in containers containing homogenized sediment, hydrated with deionized (DI) water, and incubated at standardized temperature, lighting and humidity conditions. A nutrient solution was added to each test chamber to ensure adequate growth during the study. The duration of the study was extended beyond the original termination date to ensure adequate plant material required by the analytical laboratory for nutrient / mineral analyses.

Chemical analysis for confirmation of the concentrations of desired nutrients / minerals was conducted at Columbia Analytical Services, Inc. (CAS) in Kelso, Washington, USA.

Table 1. Sediment Collection and Receipt

Sample ID	Collection Date and Time	FCETL No.	Date of Receipt	Cooler Temp. at Arrival (°C)
APG-06-MA-060311 (Aquablok)	06/03/11 @ 1515	25060	June 9, 2011	14.1
APG-15-MA-060311 (Site Control, No Treatment)	06/03/11 @ 1605	25061	June 9, 2011	14.1
APG-02-MA-060311 (Slurry Spray)	06/03/11 @ 1620	25062	June 9, 2011	14.1
APG-16-MA-060311 (SediMite)	06/03/11 @ 1636	25063	June 9, 2011	14.1

Note: See Appendix A for copies of chains of custody records

MATERIALS AND METHODS

Laboratory Control Sediment

The laboratory control sediment was artificial sediment produced in the laboratory, based on Walsh (1991). The composition of the artificial sediment is given (Table 2).

Table 2. Composition of Laboratory Formulated Sediment (Control)

Material	Weight (g) (percent)
2-3 mm sieved sphagnum peat	210 (7)
Colloidal kaolinite clay	240 (8)
Fine silica sand	2,160 (72)
Medium silica sand	300 (10)
Coarse silica sand	90 (3)

Prior to mixing, the sphagnum moss was sieved using a 2 mm sieve, rinsed with deionized water and baked overnight at 105°C. Each grain size of silica sand was rinsed with deionized water until the water ran clear and then baked overnight at 105°C. All ingredients were combined and mixed together for at least 15 minutes. Calcium carbonate was added at approximately 1% (by dry weight) to raise the sediment pH from 3.8 to 6.5. An additional 30 grams of calcium carbonate was added to the formulated sediment in an effort to raise the pH to ~ 7.0 s.u.; however, the additional calcium carbonate did not alter the sediment pH. Therefore, the laboratory control sediment was tested without further attempts to adjust the sediment pH.

Test Sediment Preparation

The day prior to test initiation, sediment from four sample sites each consisting of four sediment cores was individually homogenized (in a stainless steel mixing bowl using a stainless steel spoon) for a minimum of three minutes. Each homogenized sediment replicate was distributed to a labeled test chamber (each core was considered one replicate for that treatment). The average weight of sediment per test chamber was 497 g (range of 216 – 566 g), depending on the volume of sediment received for each replicate / core.

Laboratory control sediment was also homogenized for a minimum of three minutes and then distributed to appropriately labeled test chambers.

Test Organism

Test species was *Echinochloa crusgalli*, FCETL lot #95-59, obtained from Wildlife Industries. Seeds were stored in a freezer (target temperature of ≤ -10°C) when not in use. Prior to test initiation, approximately 100 seeds were placed into moist sand and monitored to verify viability. Since there was sufficient seed germination, seeds were determined to be adequately viable.

On September 20, 2011, 10 days prior to test initiation, *E. crusgalli* seeds were allowed to warm to room temperature. Seeds were then planted in glass trays containing clean medium grain silica sand wetted with laboratory deionized water and covered with clear plastic wrap. Trays were placed in the same environmental bath used for testing, with the same temperature and lighting regime. Seedlings were removed from the trays, rinsed with Milli-Q water, and planted in the sediment in the test chambers on September 30, 2011 (day 0). Information on the source age, and other relevant details on the seeds used in this study are below (Table 3).

Table 3. Test Organism Information

Species and Lot Number	*Echinochloa crusgalli* seedlings, FCETL Lot 95-59
Age	10 days old (planted September 20, 2011)
Source	Wildlife Industries (Bloomfield Hills, MI)
Germination Conditions	Germinated on clean medium silica sand
Reference Toxicant Testing	Initiated January 20, 2012 using potassium chloride (KCl)

Test Chambers

Test chambers were ~710 ml tapered rectangular plastic containers. Several small holes were drilled in the bottom of each container to allow for water drainage. Test chambers were placed within a pattern according to a computer-generated random design. Each test chamber was labeled with the sediment site, the random location, and replicate letter (i.e. A, B, C, and D).

Test Conditions

Test chambers were held in an experimental room in a water bath. Water in the bath was kept at a constant level and the experimental chambers were placed on a plexiglas sheet that was held above the water level. Bath water was maintained at room temperature. The entire water bath was enclosed (including the top) with plastic sheeting to help maintain a constant environment (i.e., humidity). Target air temperature and humidity were 24 ± 10°C and 70 ± 25%, respectively. The photoperiod was continuous illumination. Light intensity was a target of 400 ± 20 ft-c. Other relevant test design and conditions are reported below (Table 4).

Table 4. Test Conditions and Design

Test Type	Static chronic test
Test Endpoints	Survival and shoot growth (dry weight), shoot length, and tissue concentrations of nutrients and metals
Test Chambers	Plastic container, ~710 ml (24 oz)
Test Sediment Volume	~ 500 grams (range 216 – 566 g)
Hydration Water Volume	20 ml modified Gorsuch nutrient solution on specified test days; Milli-Q water as needed
Replicates per Treatment	4
Organisms per Replicate	20
Test Temperature	24 ± 1°C
Lighting	Fluorescent, continuous illumination
Chamber Placement	Randomized (Random Chart “JJ”)
Test Sediment Renewal	None

Test Initiation

On the day of test initiation, *E. crusgalli* seedlings (10 days old) were transplanted from silica sand to laboratory control or field sediment, as appropriate. Each plant root was rinsed with Milli-Q water to remove any residual sand. Using a clean glass probe to make 20 small holes in the wet sediment, one seedling was placed into each hole, taking care not to damage the root. Sediment was gently pushed around the root to secure it. Once planted, 20 ml nutrient solution was added to each test chamber which was then placed in the environmental bath. The study was initiated on September 30, 2011 between 1330 and 1600 hours.

Two weeks after being transplanted, laboratory control organisms appeared to be in poor condition (browning, yellowing, wilting) when compared to both plants in test treatments (field sediments) and excess organisms still growing in sand. Plants grown in formulated sediment during preliminary growth experiments did not exhibit this response. There was one difference

between the preparations of formulated sediment used in preliminary experiments compared to the preparation used to initiate the definitive test: moss in the definitive test was soaked and rinsed with Milli-Q water in an attempt to reduce the acidity of the laboratory control sediment. Sphagnum peat moss that had not been “washed” was used in the preparation of preliminary sediment, while “washed” moss was used in the laboratory control sediment. Given the response of the laboratory controls, we initiated a new set of laboratory controls using a new batch of formulated sediment that was made with unwashed sphagnum peat moss. Seedlings remaining (unused in testing) from the initial transplant (September 30, 2011) were used to initiate these additional (n=4) laboratory control chambers on October 14, 2011.

Test Monitoring

Test temperature (air temperature) was monitored and recorded daily using a minimum / maximum thermometer in the test enclosure. Humidity was also monitored and recorded daily throughout the test with a minimum/maximum meter, but only the real-time reading was recorded on a daily basis. Light intensity was measured at approximately 5 different locations throughout the test area on a given day.

Sediment hydration was visually monitored daily for all test chambers. If hydration was determined necessary, Milli-Q water was added to each test chamber. Modified Gorsuch nutrient solution was added to all test chambers on select days throughout the study at a rate of 20 ml per test chamber (see below).

The number of surviving seedlings was recorded daily. Observations of plant appearance were made throughout the test.

Nutrient Solution

The nutrient solution was modified from a formula provided by Gorsuch et al. (2008) (Table 5). The formula for the nutrient solution used in the study is shown in the table below.

Table 5. Composition of the Nutrient Solution Added in the Definitive Plant Study

Salts Added to Nutrient Solution	Target Concentration (mg/L)	Quantity per 2 Liters (g)
$Ca(NO_3)_2 \cdot 4H_2O$	200	0.400
KNO_3	50	0.100
KH_2PO_4	50	0.100
$MgSO_4 \cdot 7H_2O$	50	0.100
$Fe\ NH_4\ (SO_4)_2 \cdot 12H_2O$	5	0.010

Note: This is the solution prior to dilution with deionized water.

Nutrient solution was initially added twice per week to ensure adequate nutrient for proper growth while trying not to artificially influence nutrient uptake. As plants grew, the supplementation with nutrient solution was increased to 3-4 times per week. Nutrient solution was added using the same regime for all treatments so the amount added was the same among treatments.

Test Termination

This study had two termination dates. The first termination date involved plants in the field sediment samples being tested. The second termination date was for the laboratory control plants. On December 16, 2011 (day 77), the number of surviving plants was recorded in all the test/site sediment plant chambers. Surviving plants were gently removed from test sediment not to damage the plant. Shoot biomass was separated from root biomass by cutting the plant in two at the hypocotyl-radicle junction. All shoot biomass (plant) was rinsed with Mill-Q water to remove extraneous sediment or dirt on the plant. The length of each shoot was measured from the base to the extent of the longest leaf. All shoots from a replicate were combined into a tared aluminum pan and measured for wet weight (± 0.1 mg) and then dry weight after shoots were dried at approximately 85˚C for a minimum of 24 hours.

On December 30, 2011 (day 77 for controls initiated on October 14) the control plants were terminated in the same manner described above. The control plants were terminated two weeks after the field sediment plants because they were initiated two weeks later. Therefore, the test duration was 77 days for all plants. Pictures taken during the study are included in Appendix B.

Analytical

Sediment from all replicates within a treatment was pooled to produce a single analytical sample for each treatment. Sediment was mixed thoroughly prior to collection. The sample was placed in a 6 oz. glass container and stored on ice (~4°C) until analysis at CAS. Sediment samples (collected at test end due to limited volume, minus root material) were analyzed for boron, calcium, copper, iron, magnesium, manganese, phosphorus, potassium, sodium, sulfur, and zinc (EPA method 200.7), nitrogen (%, EPA method 440.0), total solids (method 160.3M), total organic carbon (ASTM D419-82M), pH (9045D, CAS; SM4500-H^+ B, FCETL).

Dried plants (after biomass and length determination) for individual replicates were placed in individual Ziploc® bags and stored frozen until analysis. Plant samples were analyzed for boron, calcium, copper, iron, magnesium, manganese, phosphorus, potassium, sodium, sulfur, and zinc (EPA method 200.7) and nitrogen (%, EPA method 440.0).

An aliquot of modified Gorsuch nutrient solution was also sub-sampled and sent for analysis. The nutrient solution was analyzed for boron, calcium, copper, iron, magnesium, manganese, phosphorus, potassium, sodium, sulfur, and zinc (EPA method 200.7), nitrate/nitrite (EPA method 353.2), and total Kjeldahl nitrogen (ASTM D1426-93B).

All the samples were shipped (on ice) to Columbia Analytical Services, Inc. (CAS), an independent laboratory, located in Kelso, Washington, USA.

Statistical Analysis

Statistical analyses were conducted using four different methods. Statistics were completed comparing treatments to the laboratory control; second, statistics were completed comparing to the site control, excluding the laboratory control; third, statistics were performed using stepwise linear regression analysis to determine if soil parameter concentrations impacted plant nutrient uptake. The final statistical analysis was performed on plant nutrient uptake factors (i.e., plant

nutrient concentration divided by the soil nutrient concentration). Each approach is described in more detail below.

All hypothesis testing was performed using Toxstat Version 3.5 (WEST, Inc. and Gulley 1996). Data were first tested for normality and homogeneity assumptions using Shapiro-Wilk's Test and Bartlett's Test, respectively ($p \leq 0.01$). Data that did not meet assumptions of normality and homogeneity were transformed using Log Base 10 (y) or Square Root (y) and then tested by analysis of variance, followed by a two-tailed multiple comparison test. Growth (length, wet weight, and dry weight) and plant nutrient concentrations differences were compared using an appropriate multiple comparison test ($p \leq 0.05$). Experimental treatments were first compared to the laboratory control and then secondly compared to the site control (APG-15), excluding the laboratory control. Plant nutrient concentrations were subsequently compared among all treatments (and not just against the control or field control) using Tukey's Method of Multiple Comparisons (parametric data) or Dunn's Multiple Comparison / Kruskal-Wallis (non-parametric data) ($p \leq 0.05$).

Stepwise linear regressions were performed using Statistix 8 (Analytical Software 2003) on plant nutrient concentrations, as well. These linear regressions evaluated if any of 14 sediment parameters (12 nutrients as measured in the sediment, average sediment pH, and/or total organic carbon [% TOC]) affected nutrient update in the plants. Nitrogen was converted from a percent basis to weight: weight basis (mg/kg) for these analyses. Control data were excluded from this analysis so as not to bias the results of the response and evaluate the effect of the field sediment samples.

Finally, uptake factors were determined by dividing the plant tissue concentration for each nutrient by its respective soil nutrient. Statistics were then carried out comparing uptake factors in the treated samples compared to either the laboratory control or the site control. When the site control was used, the laboratory control was excluded. The data was then tested by analysis of variance, followed by a two-tailed Dunnett's procedure ($p \leq 0.05$) comparing the organism performance and plant nutrient uptake factors in the experimental treatments with that observed in the laboratory control and then in the site control (APG-15).

Reference Toxicant

A 14-day reference toxicant test was conducted from January 20, 2012 to February 3, 2012 using potassium chloride (KCl) in medium sand. The *E. crusgalli* seedlings used were from the same lot of seeds used in the nutrient uptake test. Nominal concentrations tested (expressed as mg KCl/L) were 4,000, 8,000, 12,000, 16,000, and 32,000 mg/L, plus a control (no added KCl). Solutions were prepared by adding and/or diluting (using Milli-Q) a solution of the highest test concentration into 100 g of dry medium sand. Four test chambers with twelve *E. crusgalli* seedlings were tested for each treatment. Testing was conducted in a 24 ± 2°C environmental chamber. The 14-day IC25 was determined for survival and a 14-day IC_{25} was determined for shoot dry weight and expressed as measured mg Cl^-/L (Table 6).

Table 6. Reference Toxicant Test Results for *E. crusgalli*

14-Day IC_{25}		FCETL Historical 95 % Confidence Limits	
Endpoint	**Value**	**Low**	**High**
Survival	4,085	2,644	12,110
Shoot dry weight	2,924	1,550	11,738

Note: Values are expressed as mg/L chloride

RESULTS

Test Conditions

The temperature measured in the test chambers and water bath along with the humidity measured in the water bath area are reported in Table 7. Data are presented separately for the controls since the controls were re-started ~ 2 weeks after the treatments.

Table 7. Physical Data Measured During the Definitive Study

Sample ID	Mean Sediment Temperature (°C)[a]	Water Bath Temperature (°C)[b]	Mean Humidity (%)
Laboratory Control	18.2	20.8	36.2
APG-06-MA-060311	18.7	20.9	40.7
APG-15-MA-060311	18.6		
APG-02-MA-060311	18.9		
APG-16-MA-060311	18.5		

[a] Overall mean of daily temperature measurements
[b] Mean of all daily average temperatures

The light intensity measured in the water bath during the definitive study is reported in Table 8. Light intensity averaged 374 ft-c during the study.

Table 8. Light Intensity Measured for the Water Bath During the Definitive Study

Day	Light intensity (ft.-c)
0	388
28	371
35	365
45	310
46	401
52	380
56	382
63	381
77	384

Analytical Results

This section summarizes all the analytical results from the definitive study. Metal and nutrient concentrations measured in the modified Gorsuch nutrient solution added to test chambers during the study are reported in Table 9.

Table 9. Analytical Results of Modified Gorsuch Nutrient Solution

Parameters [a]	Stock Solution
Boron (µg/L)	< 50
Calcium (µg/L)	33,900
Copper (µg/L)	< 10
Iron (µg/L)	954
Magnesium (µg/L)	4,590
Manganese (µg/L)	< 5.0
Phosphorus (µg/L)	11,800
Potassium (µg/L)	35,000
Sodium (µg/L)	< 200
Sulfur (µg/L)	7,250
Zinc (µg/L)	< 10
Nitrate + Nitrite as N (mg/L)	28.5
TKN (mg/L)	1.64

[a] All parameters determined by CAS, Kelso, WA.

The metals / element concentrations measured in the sediment samples are provided below (Table 10). Concentrations for some metals (e.g., B) were similar among treatments, however, most metals / element concentrations varied among treatments. No single sediment had the highest analyte concentration for all parameters. In addition, analytical summaries are provided in Appendix C.

Table 10. Characteristics of Sediments in Definitive Study

Parameters (mg/kg)[a]	Laboratory Control	APG-02-MA060311	APG-06-MA060311	APG-15-MA060311	APG-16-MA060311
Boron	3.1 U	3.8	4.5	5.5	6.0
Calcium	7,600	2,170	6,600	29,600	5,140
Copper	1.3	245	70.9	869	389
Iron	629	14,800	12,600	19,100	21,500
Magnesium	95.5	1,360	3,890	5,440	2,680
Manganese	10.2	253	259	338	303
Phosphorus	149	809	518	1,050	800
Potassium	127	294	304	542	610
Sodium	62.1 U	121	99	246	327
Sulfur	113	5,050	5,180	10,400	14,200
Zinc	3.1	895	931	5,330	5,360
Nitrogen (%)	0.06 J	1.27	0.35	0.80	0.72
pH (s.u.; initial / final)	6.5 / 7.63	6.1 / 5.03	6.7 / 6.58	7.0 / 7.15	6.5 / 6.21
% Solids	62.5	25.5	44.5	33.3	33.6
Total organic carbon (%)	2.79	14.4	6.43	15.5	10.6

[a] All parameters determined by CAS, Kelso, WA; except initial pH which was determined at the FCETL.
U = The analyte was analyzed for but not detected ("non-detect") at or above the MDL.
J = The result is an estimated value (result was between the MDL and MRL).

Metal / element concentrations measured in replicate plant samples are presented in the following five tables (Tables 11-15). Variation in the plant measurements may be more of a function of variability in the sediment cores as each replicate sample represented one sediment core. Since analytical for sediments was measured on a composite of the four core samples, we did not have individual analyte concentrations for each core / replicate sample.

Table 11. Plant Tissue Characterization – Laboratory Control

Parameters (mg/kg)[a]	Rep A	Rep B	Rep C	Rep D	Average	Standard Deviation
Boron	6.6	6.0	5.8	6.3	6.18	0.35
Calcium	19,400	19,800	23,200	16,600	19,750	2,705
Copper	2.9	2.4	2.0	1.8	2.28	0.49
Iron	64.7	51.0	49.9	41.8 J	51.85	9.50
Magnesium	12,500	10,200	10,700	10,400	10,950	1,054
Manganese	263	203	189	167	205.5	41.10
Phosphorus	3,160	2,760	3,140	2,440	2,875	343.5
Potassium	18,800	14,400	15,100	14,700	15,750	2,053
Sodium	124	88.6	99.5	84.4	99.13	17.76
Sulfur	5,070	4,600	3,880	3,440	4,248	727.5
Zinc	38.7	34.6	33.7	25.0	33.00	5.76
Nitrogen (%)	0.92	0.93	1.05	0.83	0.93	0.09

[a] All parameters determined by CAS, Kelso, WA.
J = Value was estimated because it was less than 20 times the amount found in the method blank.

Table 12. Plant Tissue Characterization - APG-02-MA060311

Parameters (mg/kg)[a]	Rep A	Rep B	Rep C	Rep D	Average	Standard Deviation
Boron	17.2	15.3	17.0	28.5	19.50	6.06
Calcium	7,200	6,770	7,280	22,400	10,912	7,662
Copper	16.4	13.2	26.9	26.2	20.68	6.91
Iron	146	348	415	91.3	250.1	155.8
Magnesium	12,900	10,700	11,300	12,700	11,900	1,071
Manganese	2,060	1,160	1,380	2,370	1,742	567.2
Phosphorus	2,660	2,310	2,320	1,920	2,302	302.5
Potassium	14,900	16,100	18,300	17,300	16,650	1,473
Sodium	1,870	1,240	946	6,260	2,579	2,484
Sulfur	14,000	13,200	16,400	32,400	19,000	9,036
Zinc	434	345	436	1,870	771.2	733.7
Nitrogen (%)	0.9	0.97	0.83	0.81	0.88	0.07

[a] All parameters determined by CAS, Kelso, WA.

Table 13. Plant Tissue Characterization - APG-06-MA060311

Parameters (mg/kg)[a]	Rep A	Rep B	Rep C	Rep D	Average	Standard Deviation
Boron	13.0	11.3	12.5	11.3	12.02	0.86
Calcium	24,500	9,410	11,900	9,170	13,745	7,275
Copper	7.3	5.3	6.5	9.1	7.05	1.59
Iron	122	281	121	169	173.2	75.24
Magnesium	14,900	11,300	14,800	14,800	13,950	1,767
Manganese	181	427	275	880	440.8	309.9
Phosphorus	1,930	2,040	2,030	2,360	2,090	186.7
Potassium	16,500	19,900	19,000	16,500	17,975	1,742
Sodium	4,000	727	2,800	1,690	2,304	1,413
Sulfur	28,900	15,600	19,600	19,400	20,875	5,658
Zinc	323	162	392	326	300.8	97.83
Nitrogen (%)	0.75	0.82	0.79	0.78	0.78	0.03

[a] All parameters determined by CAS, Kelso, WA.

Table 14. Plant Tissue Characterization - APG-15-MA060311 (Site Control)

Parameters (mg/kg)[a]	Rep A	Rep B	Rep C	Rep D	Average	Standard Deviation
Boron	8.8	6.9	10.7	9.6	9.00	1.60
Calcium	21,400	23,600	44,200	39,600	32,200	11,392
Copper	24.4	11.4	12.4	14.0	15.55	6.00
Iron	105	61.7	196	97.0	114.9	57.2
Magnesium	10,400	9,340	10,100	10,500	10,085	524.9
Manganese	496	342	421	437	424.0	63.47
Phosphorus	2,060	2,090	1,730	1,780	1,915	186.3
Potassium	18,000	18,300	14,300	16,300	16,725	1,841
Sodium	5,640	3,490	11,200	4,370	6,175	3,464
Sulfur	25,200	23,600	42,900	36,800	32,125	9,284
Zinc	775	287	809	530	600.2	243.0
Nitrogen (%)	0.74	0.77	0.67	0.74	0.73	0.04

[a] All parameters determined by CAS, Kelso, WA.

Table 15. Plant Tissue Characterization - APG-16-MA060311

Parameters (mg/kg)[a]	Rep A	Rep B	Rep C	Rep D	Average	Standard Deviation
Boron	7.3	9.7	11.6	11.9	10.13	2.12
Calcium	17,300	17,000	16,200	15,800	16,575	694.6
Copper	8.5	10.5	9.0	10.3	9.58	0.98
Iron	76.5	185	120	53.5	108.8	57.8
Magnesium	7,870	8,040	9,380	8,380	8,418	675.8
Manganese	245	666	520	618	512.2	188.2
Phosphorus	1,440	1,730	2,070	1,790	1,758	258.4
Potassium	12,700	18,700	18,900	14,600	16,225	3,074
Sodium	5,810	5,520	5,170	3,700	5,050	937.3
Sulfur	18,700	18,200	19,400	19,800	19,025	713.6
Zinc	448	979	864	1,200	872.8	315.6
Nitrogen (%)	0.81	0.69	0.79	0.77	0.76	0.05

[a] All parameters determined by CAS, Kelso, WA.

Survival and Growth

Overall, plant survival in the laboratory control was 97.5% and 98.7% for the site control at test termination. Mean plant percent survival in all field sites ranged from 98.7 to 100% (Table 16) and was not statistically different from either control. A copy of the data package from the study is included in Appendix D, while copies of the statistical analyses are included in Appendix E.

Table 16. Biological Data – Survival

Treatment	Survival (%)	Significant Reduction Relative to Laboratory Control?	Significant Reduction Relative to Site Control?
Laboratory Control	97.5	N/A	N/A
Site Control - APG-15	98.7[a,b]	No	N/A
APG-02	100[a]	No	No
APG-06	100[a]	No	No
APG-16	100[a]	No	No

[a] One organism was sacrificed on Day 66 from replicate A for weight analysis
[b] At test takedown, 24 organisms were observed in replicate D and were included in analysis of survival, length and weight

Table 17. Biological Data – Growth (Wet/Dry Weight and Length)

Treatment	Mean Wet Weight (g)[a]	Significant Difference Relative to Laboratory Control?	Significant Difference Relative to Site Control?	Mean Dry Weight (g)[a]	Significant Difference Relative to Laboratory Control?	Significant Difference Relative to Site Control?	Mean Length (mm)[b]	Significant Difference Relative to Laboratory Control?	Significant Difference Relative to Site Control?
Laboratory Control	0.223	N/A	N/A	0.065	N/A	N/A	250.8	N/A	N/A
APG-02	0.199	No	No	0.052	No	No	224.4	No	No
APG-06	0.199	No	No	0.054	No	No	224.7	No	No
APG-15 (Site Control)	0.214	No	---	0.061	No	---	223.5	No	---
APG-16	0.306	YES	YES	0.088	YES	YES	266.1	No	YES

[a] Both wet and dry weight are based on the original number of plants
[b] Length was measured for individual plants within each replicate and then averaged among replicates

At test termination, wet weight of surviving shoots from each treatment replicate was measured. An average wet weight was determined for each treatment and ranged from 0.199 g (sites APG-02-MA-060311 and APG-06-MA060311) to 0.306 g (site APG-16-MA-060311). Mean wet weight was 0.223 g for the laboratory control and 0.214 g for the site control. Plants from the APG-16-MA-060311 site were statistically higher in wet weight compared to the laboratory control and the site control (Table 17). No other sites showed differences to the controls.

Average dry weight for each treatment ranged from 0.052 g (site APG-02-MA-060311) to 0.088 g (site APG-16-MA-060311). Mean dry weight was 0.065 g for the laboratory control and 0.061 g for the site control (Table 17). One site was determined to be statistically different (i.e., greater) compared to the laboratory control and compared to the site control based on the dry shoot weight (APG-16-MA-060311).

Shoot length of each of the surviving plants was measured to the nearest millimeter and recorded at test termination. Average shoot lengths (from individual replicates) ranged from 115 mm (site APG-15-MA-060311 replicate D) to 360 mm (site APG-16-MA-060311 replicate A). The mean length was 250.8 mm for the laboratory control and 223.5 mm for the site control, while those in the other treatments ranged from 224.4 to 266.1 mm (Table 17). Shoot length of the field treatments was not statistically different compared to the laboratory control; however, the shoot length of one site (APG-16-MA-060311) was statistically different (greater) compared to the site control.

From these results, it appears that the treatment for the APG-16 site significantly increased plant growth (length and weight) compared to the unamended soil sample (APG-15).

Plant Nutrient Concentrations – Comparison to Laboratory Control and Site Control

Comparison to Laboratory Control

Evaluations were made for nutrient / element concentrations among field treatments compared to the laboratory control (Table 18). In evaluating the data, statistical significances observed reflect either a significance that is lower or higher relative to the laboratory control. Significances are indicated by an asterisk in Tables 18 -21.

Comparison to Site Control

Evaluations were also made for nutrient / element concentrations among field treatments compared to the site control (APG-15). For these analyses, the laboratory control was excluded. In evaluating the data, statistical significances observed reflect either a significance that was lower or higher relative to the site control. These significances are designated in Tables 18-21 by the use of an asterisk.

Table 18. Statistical Significance of Plant Nutrient Concentrations (B, Ca, Cu) among Sites Compared to Laboratory and Site Controls

Site	BORON			CALCIUM			COPPER		
	Avg. Nutrient (mg/kg)	Statistical Significance		Avg. Nutrient (mg/kg)	Statistical Significance		Avg. Nutrient (mg/kg)	Statistical Significance	
		Versus Lab Control	Versus Site Control		Versus Lab Control	Versus Site Control		Versus Lab Control	Versus Site Control
Laboratory Control	6.18	---	---	19,750	---	---	2.28	---	---
APG-15 (Site Control)	9.00	*	---	32,200	NS	---	15.6	*	---
APG-02	19.5	*	*	10,912	NS	*	20.7	*	NS
APG-06	12.0	*	NS	13,745	NS	*	7.05	*	NS
APG-16	10.1	*	NS	16,575	NS	*	9.58	*	NS

NS = no significance

Plant boron concentrations were lowest in the laboratory control (6.18 mg/kg) and highest in APG-02 (19.5 mg/kg). Boron concentrations were found statistically significant in all treatments when compared to the laboratory control (Table 18). This trend was also seen in plant copper, phosphorus, sodium, sulfur, and zinc concentrations (Tables 18-21). When comparing the treatments to the site control for plant boron, APG-02 was significant (statistically high), while all other treatments were not significant. This trend was also observed with manganese and nitrogen for the site control.

Plant calcium concentrations were lowest in APG-02 (10,912 mg/kg) and highest in APG-15 (32,200 mg/kg). None of the field treatments had statistically significant differences in calcium relative to the laboratory control (Table 18). This lack of statistically significant differences was also observed with plant potassium concentrations (Table 20). In comparing plant calcium concentrations for the treatments to the site control, all treatments were statistically lower than the site control.

Plant copper concentrations were lowest in the laboratory control (2.28 mg/kg) and highest in APG-02 (20.7 mg/kg). Copper concentrations were found to be significantly elevated in all treatments when compared to the laboratory control (Table 18). Plant copper concentrations for the field treatments compared to the site control did not indicate any statistical significance. This lack of significance compared to the site control was also observed for iron, phosphorus, potassium, sodium, sulfur, and zinc (Tables 19-21).

Table 19. Statistical Significance of Plant Nutrient Concentrations (Fe, Mg, Mn) among Sites Compared to Laboratory and Site Controls

Site	IRON			MAGNESIUM			MANGANESE		
	Avg. Nutrient (mg/kg)	Statistical Significance		Avg. Nutrient (mg/kg)	Statistical Significance		Avg. Nutrient (mg/kg)	Statistical Significance	
		Versus Lab Control	Versus Site Control		Versus Lab Control	Versus Site Control		Versus Lab Control	Versus Site Control
Laboratory Control	51.8	---	---	10,950	---	---	206	---	---
APG-15 (Site Control)	115	NS	---	10,085	NS	---	424	NS	---
APG-02	250	*	NS	11,900	NS	NS	1,742	*	*
APG-06	173	*	NS	13,950	*	*	441	NS	NS
APG-16	109	NS	NS	8,418	*	NS	512	*	NS

NS = no significance

Plant iron concentrations were lowest in the laboratory control and highest in APG-02. Not only was plant iron for APG-02 significantly higher than the laboratory control but APG-06 was also significantly higher (Table 19). Plant iron concentrations when compared to the site control did not illicit any statistical differences.

Plant magnesium concentrations were lowest in APG-16 and highest in APG-06. Both of these treatments were significant relative to the laboratory control (Table 19). APG-06 was statistically high while APG-16 was statically low. In comparison to the site control, plant magnesium was statically significant (high) for APG-06. All other treatments were not statistically different compared to the site control (Table 19).

Plant manganese concentrations were lowest in the laboratory control and highest in APG-02. APG-02 and APG-16 were both found to have statistically elevated manganese concentrations relative to the laboratory control (Table 19). Plant manganese concentrations were significantly higher at APG-02 when comparing to the site control. However, no other treatments were found to be significantly different from the site control (Table 19).

Table 20. Statistical Significance of Plant Nutrient Concentrations (P, K, Na) among Sites Compared to Laboratory and Site Controls

Site	PHOSPHORUS			POTASSIUM			SODIUM		
	Avg. Nutrient (mg/kg)	Statistical Significance		Avg. Nutrient (mg/kg)	Statistical Significance		Avg. Nutrient (mg/kg)	Statistical Significance	
		Versus Lab Control	Versus Site Control		Versus Lab Control	Versus Site Control		Versus Lab Control	Versus Site Control
Laboratory Control	2,875	---	---	15,750	---	---	99.1	---	---
APG-15 (Site Control)	1,915	*	---	16,725	NS	---	6,175	*	---
APG-02	2,302	*	NS	16,650	NS	NS	2,579	*	NS
APG-06	2,090	*	NS	17,975	NS	NS	2,304	*	NS
APG-16	1,758	*	NS	16,225	NS	NS	5,050	*	NS

NS = no significance

Plant phosphorus concentrations were lowest in APG-16 (1,758 mg/kg) and highest in the laboratory control (2,875 mg/kg). All treatments had statistically lower phosphorus concentrations compared to the laboratory control (Table 20). No treatments were statistically significant compared to the site control for plant phosphorus concentrations (Table 20).

Plant potassium concentrations were fairly similar among all treatments; but were lowest in the laboratory control (15,750 mg/kg) and highest in APG-06 (17,975 mg/kg). None of the treatments were statistically different relative to the laboratory or site controls (Table 20).

Plant sodium concentrations were lowest in the laboratory control (99.1 mg/kg) and highest in APG-15 (6,175 mg/kg). All treatment concentrations were statistically higher than the laboratory control. However, none of the field treatments had statistical different sodium concentrations from the site control.

Table 21. Statistical Significance of Plant Nutrient Concentrations (S, Zn, N) among Sites Compared to Laboratory and Site Controls

Site	SULFUR			ZINC			NITROGEN		
	Avg. Nutrient (mg/kg)	Statistical Significance		Avg. Nutrient (mg/kg)	Statistical Significance		Avg. Nutrient (mg/kg)	Statistical Significance	
		Versus Lab Control	Versus Site Control		Versus Lab Control	Versus Site Control		Versus Lab Control	Versus Site Control
Laboratory Control	4,248	---	---	33.0	---	---	9,325	---	---
APG-15 (Site Control)	32,125	*	---	600	*	---	7,300	*	---
APG-02	19,000	*	NS	771	*	NS	8,775	NS	*
APG-06	20,875	*	NS	301	*	NS	7,850	*	NS
APG-16	19,025	*	NS	873	*	NS	7,650	*	NS

NS = no significance

Plant sulfur concentrations were lowest in the laboratory control (4,248 mg/kg) and highest in APG-15 (32,125 mg/kg). All treatments were statistically higher than the laboratory control in sulfur (Table 21). Conversely, when comparing sulfur concentrations among treatments to the site control, no statistical differences were observed (Table 21).

Plant zinc concentrations were lowest in the laboratory control (33.0 mg/kg) and highest in APG-16 (873 mg/kg). All treatments were statistically significant when compared to the laboratory control (Table 21). Once again, when comparing treatments to the site control no statistical differences were indicated.

Plant nitrogen concentrations were lowest in APG-15 (7,300 mg/kg) and highest in the laboratory control (9,325 mg/kg). All treatments, except APG-02, were statistically lower to the laboratory control in nitrogen (Table 21). In comparing the field treatments to the site control, APG-02 was the only site that was statistically different (elevated).

Plant Nutrient Concentrations – Comparison among Sites

Comparisons were also made for nutrient / element concentrations among treatments including the laboratory control (Table 22; Figures 1a-d). In comparing these results, treatments with the same letter were not statistically different from each other, while treatments with different letters were determined to be statistically different from one another using a multiple comparison method.

Plant boron concentrations were lowest in the laboratory control and highest in AGP-02, with the difference being statistically significant (Figure 1c). Boron concentrations in the other three treatments did not exhibit a statistically significant difference from the laboratory control and APG-02 site (Table 22). The same pattern was observed with iron and manganese (Table 22; Figure 1d).

Plant calcium concentrations were lowest in APG-02, and highest in APG-15 (Figure 1a). These treatments were statistically different from each other but not from the other sites or the laboratory control (Table 22).

Table 22. Statistical Similarities of Plant Nutrient Concentrations Among Sites

	mg/kg dry weight											
	Boron		Calcium		Copper		Iron		Magnesium		Manganese	
Treatment	Mean	Similarities	Mean	Similarities	Mean	Similarities	Mean	Similarities	Mean	Similarities	Mean	Similarities
Laboratory Control	6.18	B	19,750	AB	2.28	B	51.8	B	10,950	B	206	B
APG-02	19.5	A	10,912	B	20.7	A	250	A	11,900	AB	1,742	A
APG-06	12.0	AB	13,745	AB	7.05	AB	173	AB	13,950	A	441	AB
APG-15 (Site Control)	9.00	AB	32,200	A	15.6	A	115	AB	10,085	BC	424	AB
APG-16	10.1	AB	16,575	AB	9.58	AB	109	AB	8,418	C	512	AB

	mg/kg dry weight												
	Phosphorus		Potassium		Sodium		Sulfur		Zinc		Nitrogen		
Treatment	Mean	Similarities	Mean	Similarities	Mean	Similarities	Mean	Similarities	Mean	Similarities	Mean (%)	Similarities	Mean[a]
Laboratory Control	2,875	A	15,750	A	99.1	B	4,248	B	33.0	B	0.93	A	9,325
APG-02	2,302	AB	16,650	A	2,579	AB	19,000	AB	771	AB	0.88	AB	8,775
APG-06	2,090	B	17,975	A	2,304	AB	20,875	AB	301	AB	0.78	BC	7,850
APG-15 (Site Control)	1,915	B	16,725	A	6,175	A	32,125	A	600	AB	0.73	C	7,300
APG-16	1,758	B	16,225	A	5,050	A	19,025	AB	873	A	0.76	BC	7,650

[a] mg/kg nitrogen results, calculated from % data (10,000 x %N).

Plant copper concentrations were lowest in the laboratory control and highest in APG-02 and APG-15 (Figure 1c). The two highest copper treatments were statistically different from the laboratory control but were not statistically different from the other two sites (Table 22). Plant copper concentrations for APG-06 and APG-16 did not show a statistically significant difference from the laboratory control.

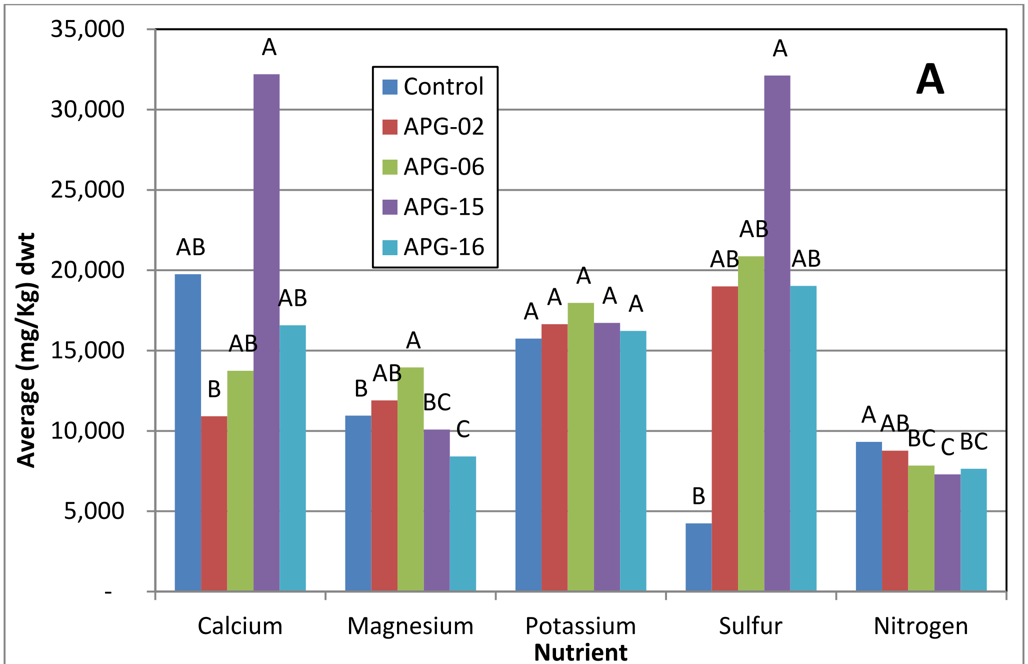
Plant magnesium concentrations were lowest for APG-16 and highest in APG-06 (Table 22; Figure 1a). The APG-16 site was statistically different from all sites except APG-15, while the APG-06 site was statistically higher than all treatments except the APG-02 site. The laboratory control was only different from the APG-06 and APG-16 sites.

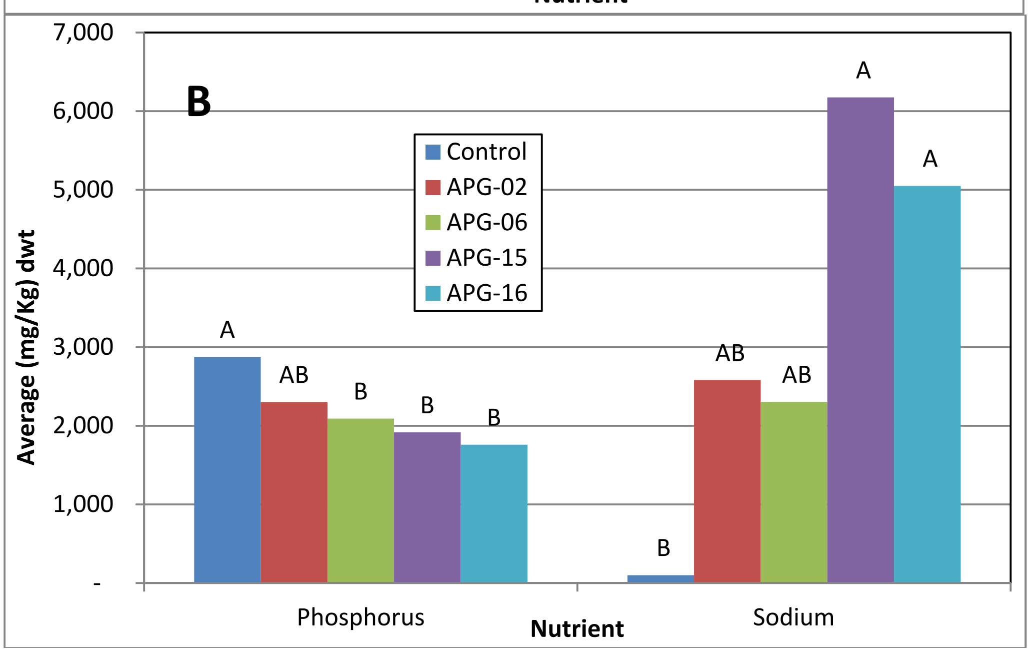
Plant phosphorus concentrations were highest in the laboratory control (2,875 mg/kg) and lowest at APG-16 (1,758 mg/kg). The laboratory control concentration was similar to that measured in the APG-02 site (Table 22; Figure 1b), but it was statistically higher than concentrations measured in plants grown in sediment from the other three sites.

Plant potassium concentrations were not statistically different among the treatments and laboratory control. The concentrations ranged from 15,750 to 17,975 mg/kg (Table 22, Figure 1a).

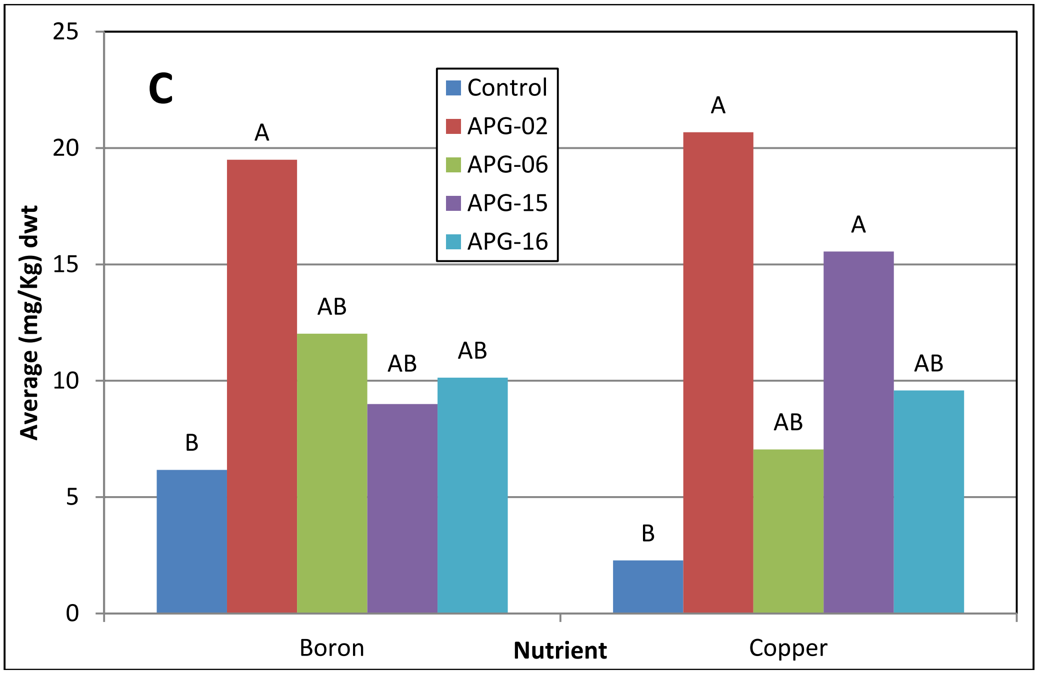
Plant sodium concentrations were highest in APG-15 (6,175 mg/kg) and lowest in the laboratory control (99.1 mg/kg) (Table 22, Figure 1b). Sodium concentrations for plants grown in APG-15 and APG-16 were statistically greater than the laboratory control. Plant sodium concentrations for APG-02 and AP-06 were not statistically different from each other, from the laboratory control, or from AGP-15 and APG-16 sodium concentrations.

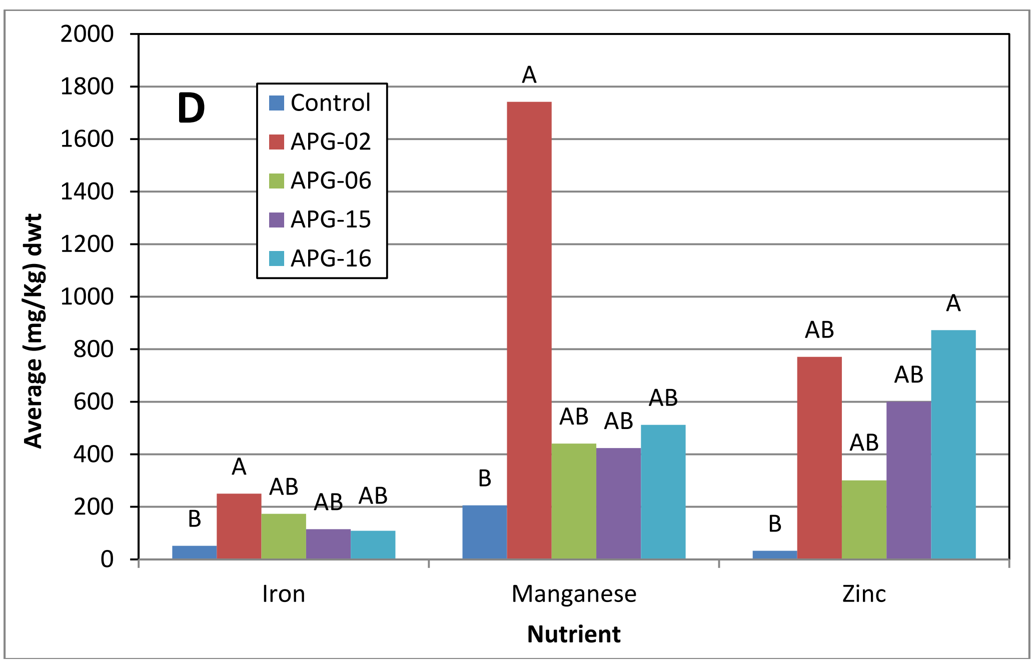
Figure 1. Similarities in Plant Nutrient Concentrations among Sites





Plant sulfur concentrations were highest at APG-15 and lowest in the laboratory control; these two treatments were statistically different from one another (Table 22, Figure 1a). Sulfur concentrations in the remaining three sites were not statistically different from each other or from APG-15 or the laboratory control.





Plant zinc concentrations were highest at APG-16 and lowest in the laboratory control (Table 22, Figure 1d) and these sites were statistically different from each other. The remaining sites were not statistically different from either the high or low sites.

Plant nitrogen concentrations were highest in the laboratory control and lowest in APG-15 (Table 18, Figure 1a). Nitrogen concentration in the laboratory control was only similar to that measured in APG-02; all other treatments had a statistically significant reduction in nitrogen relative to the laboratory control. Nitrogen concentration measured in APG-02 was not statistically different from APG-06 or APG-16 (or the laboratory control). The nitrogen concentration in the APG-15 site was not statistically different than the APG-06 or APG-16 sites.

Plant Nutrient Concentrations – Influence of Sediment Parameters

Stepwise linear regressions were performed evaluating 14 endpoints (dry weight, length, and 12 nutrients as measured in the plant), with the 14 sediment parameters (12 nutrients as measured in the sediment, average sediment pH, and total organic carbon [% TOC]). The majority of the sediment parameters were excluded from the stepwise analyses due to co-linearity. The following table lists the parameters that were not excluded based on co-linearity, and the parameters determined to significantly impact the stepwise linear regression analysis for each plant endpoint (Table 23).

Table 23. Summary of the Sediment Parameters Significantly Impacting the Plant Endpoint – Results of the Stepwise Linear Regression Analyses

Endpoint:	Sediment Parameters not excluded due to co-linearity	Sediment factor(s) significantly affecting the plant endpoint
Dry weight	Ca, Cu, Fe	Cu, Fe
Length	Ca, Cu, Fe	Cu, Fe
B (Plant)	Ca, Cu, Fe	Ca, Cu, Fe
Ca (Plant)	Ca, Cu, Fe	Ca
Cu (Plant)	Ca, Cu, Fe	Ca, Cu, Fe
Fe (Plant)	Ca, Cu, Fe, B	B
K (Plant)	Ca, Cu, Fe	None
Mg (Plant)	Ca, Cu, Fe	Fe
Mn (Plant)	Ca, Cu, Fe	Ca, Cu, Fe
N (Plant, mg/kg)	Ca, Cu, Fe	Ca, Cu, Fe
Na (Plant)	Ca, Cu, Fe	Fe
P (Plant)	Ca, Cu, Fe	Fe
S (Plant)	Ca, Cu, Fe	Ca
Zn (Plant)	Ca, Cu, Fe	None

In all cases, ten to eleven of the sediment parameters were excluded from the stepwise linear regression analysis due to co-linearity with the other variables. Calcium, copper, and iron were the three sediment parameters included in every stepwise linear regression analysis. In one case boron was an additional parameter along with these three.

Copper and iron sediment concentrations were parameters that significantly affected plant dry weight and length (Table 23). Some of the sediment parameters that were determined to be

statistically significant in impacting plant nutrient concentrations were straightforward while others were not quite as straightforward. For example, sediment calcium was determined to be significant in affecting plant calcium concentration, which is very straightforward. However, in other instances sediment iron concentrations alone were found to significantly affect the following plant nutrient concentrations: magnesium, sodium, and phosphorus. In other cases, no sediment parameter was found to explain plant nutrient concentrations (potassium and zinc). The specific results of this analysis may have been influenced since we could not pair individual sediment nutrient concentrations with individual plant results on a replicate basis since all four sediment replicates were composited prior to analysis.

Plant Nutrient Uptake Factors – Comparison to Laboratory Control and Site Control

Comparison to Laboratory Control

Evaluations were also made for nutrient uptake factors among field treatments compared to the laboratory control (Tables 24-27). Nutrient uptake factors were determined by dividing the plant nutrient tissue concentration by the soil nutrient concentration. In evaluating the data, statistical significances observed reflect either a significance that is lower or higher relative to the laboratory control. Statistical differences were indicated by an asterisk in the tables below.

Comparison to Site Control

In addition, assessments were also made for nutrient uptake factors among field treatments compared to the site control (APG-15) (Tables 24-27). Nutrient uptake factors were determined by dividing the plant nutrient tissue concentration by the soil nutrient concentration. These analyses include the field treatments and exclude the laboratory control. In evaluating the data, statistical significances observed reflect either a statistical difference that was either lower or higher relative to the site control.

Table 24. Statistical Significance of Plant Nutrient Uptake Factors (B, Ca, Cu) among Sites Compared to Laboratory and Site Controls

Site	BORON			CALCIUM			COPPER		
	Avg. Nutrient Uptake Factor	Statistical Significance		Avg. Nutrient Uptake Factor	Statistical Significance		Avg. Nutrient Uptake Factor	Statistical Significance	
		Versus Lab Control	Versus Site Control		Versus Lab Control	Versus Site Control		Versus Lab Control	Versus Site Control
Laboratory Control	3.98	---	---	2.60	---	---	1.75	---	---
APG-15 (Site Control)	1.64	*	---	1.09	*	---	0.018	*	---
APG-02	5.13	NS	*	5.02	NS	*	0.084	*	*
APG-06	2.67	*	*	2.08	NS	NS	0.100	*	*
APG-16	1.69	*	NS	3.22	NS	*	0.024	*	NS

NS= Not significant

Nutrient uptake factor for boron showed the lowest uptake in APG-15 and the highest in APG-02. All field treatments except APG-02 were statistically significant (low) when compared to the laboratory control. However, when comparing the treatments to the site control, APG-02 and APG-06 were statistically higher relative to the site control while APG-16 was not statistically different (Table 24). In comparing the uptake factor for calcium, APG-15 was statistically significant (low) compared to the laboratory control while treatments APG-02 and APG-16 were statistically higher than the site control. Copper exhibited statistically lower uptake for all treatments compared to the laboratory control, although only APG-02 and APG-06 were lower statistically lower than the site control in copper uptake (Table 24).

Table 25. Statistical Significance of Plant Nutrient Uptake Factors (Fe, Mg, Mn) among Sites Compared to Laboratory and Site Controls

Site	IRON			MAGNESIUM			MANGANESE		
	Avg. Nutrient Uptake Factor	Statistical Significance		Avg. Nutrient Uptake Factor	Statistical Significance		Avg. Nutrient Uptake Factor	Statistical Significance	
		Versus Lab Control	Versus Site Control		Versus Lab Control	Versus Site Control		Versus Lab Control	Versus Site Control
Laboratory Control	0.082	---	---	115	---	---	20.2	---	---
APG-15 (Site Control)	0.006	*	---	1.86	*	---	1.26	*	---
APG-02	0.017	*	NS	8.75	*	*	6.88	*	*
APG-06	0.014	*	NS	3.58	*	*	1.70	*	NS
APG-16	0.005	*	NS	3.14	*	*	1.69	*	NS

NS= Not significant

The uptake factor for iron revealed an opposite effect between the two controls. All treatments were statistically lower relative to the laboratory control while the treatments were similar to the iron uptake in the site control (Table 25). For magnesium uptake factor, all treatments were statistically different when compared to either the laboratory control or the site control (Table 25). The treatments were statistically low compared to the laboratory control; but, all field treatments were statistically higher than the site control. Again, all treatments were statistically lower for manganese uptake factor compared to the laboratory control. However, when comparing the treatments to the site control, APG-02 was statistically higher for iron uptake (Table 25).

Table 26. Statistical Significance of Plant Nutrient Uptake Factors (P, K, Na) among Sites Compared to Laboratory and Site Controls

Site	PHOSPHORUS			POTASSIUM			SODIUM		
	Avg. Nutrient Uptake Factor	Statistical Significance		Avg. Nutrient Uptake Factor	Statistical Significance		Avg. Nutrient Uptake Factor	Statistical Significance	
		Versus Lab Control	Versus Site Control		Versus Lab Control	Versus Site Control		Versus Lab Control	Versus Site Control
Laboratory Control	19.3	---	---	124	---	---	3.19	---	---
APG-15 (Site Control)	1.82	*	---	30.9	*	---	25.1	*	---
APG-02	2.85	*	*	56.6	*	*	21.3	*	NS
APG-06	4.04	*	*	59.2	*	*	23.3	*	NS
APG-16	2.20	*	NS	26.6	*	NS	15.4	*	NS

NS= Not significant

When looking at the uptake factors for phosphorus and potassium (which had similar responses), all uptake factors for the treatments were statistically lower relative to the laboratory control (Table 26). However, when comparing treatments to the site control, APG-02 and APG-06 were statistically different (higher). The sodium uptake factors followed a similar trend as iron in that all treatments were statistically high in contrast to the laboratory control, but were similar to the site control.

Table 27. Statistical Significance of Plant Nutrient Uptake Factors (S, Zn, N) among Sites Compared to Laboratory and Site Controls

Site	SULFUR			ZINC			NITROGEN		
	Avg. Nutrient Uptake Factor	Statistical Significance		Avg. Nutrient Uptake Factor	Statistical Significance		Avg. Nutrient Uptake Factor	Statistical Significance	
		Versus Lab Control	Versus Site Control		Versus Lab Control	Versus Site Control		Versus Lab Control	Versus Site Control
Laboratory Control	37.6	---	---	10.7	---	---	15.5	---	---
APG-15 (Site Control)	3.09	*	---	0.112	*	---	0.913	*	---
APG-02	3.76	*	NS	0.862	*	*	0.691	*	*
APG-06	4.03	*	NS	0.323	*	*	2.24	*	*
APG-16	1.34	*	*	0.163	*	NS	1.06	*	NS

NS= Not significant

For sulfur uptake factors, all treatments were statistically significant (low) compared to the laboratory control (Table 27). In comparing the site control to treatments, APG-16 was the only statistically significant (low) treatment for plant sulfur uptake factor. All treatments for both uptake factors for zinc and nitrogen were statistically significant (low) compared to the laboratory control. For zinc uptake factor, treatments APG-02 and APG-06 were statistically significant (high) compared to the site control. For nitrogen uptake, APG-02 was significantly lower than the site control while APG-06 was higher (Table 27).

SUMMARY

Japanese millet (*E. crusgalli*) seedlings were grown in sediment samples (from cores) to determine if the sediment treatment would impact survival and growth (length or weight) as well as nutrient uptake in the plants. Plant survival was not impacted in any treatments, although plant wet and dry weight was statistically higher in plants grown in soil from APG-16 compared to either the laboratory or site control plants. Plant length was not impacted compared to laboratory control plants however, plants from APG-16 were statistically longer than the site controls.

Nutrient uptake varied among sediment sites and nutrients. A multiple comparison analysis was performed to determine statistical differences and similarities among all sites and the laboratory control. This analysis allowed for nutrient uptake comparisons to the laboratory control as well as the other sites. Given the complexity of these results, they are not summarized here (see Table 22, Figures 1a-d).

A stepwise linear regression analysis was also performed to determine which 14 sediment parameters (12 nutrients measured in the sediment, sediment pH, and TOC) influenced specific plant nutrient uptake. Sediment copper and iron concentrations were found to significantly affect plant dry weight and length. For the plant nutrients, some of the results were straightforward in what sediment parameter significantly affected the plant nutrient uptake (e.g., Ca), whereas others were not as straightforward (e.g., sediment Fe affecting plant Mg, Na, and P). No sediment parameter was found to significantly explain plant uptake of K and Zn (by default this may be in part due to the contribution from the nutrient solution, especially for K).

Nutrient uptake factors were also determined using plant tissue nutrient values and soil nutrient values. Hypothesis testing was performed to determine statistical differences, either higher or lower to both the laboratory and site controls. While the interpretation of these results was not straightforward nor consistent among nutrients, the table below summarizes the statistical differences observed between the treatments (excluding the control) and the site control (Table 28).

Table 28. Summary of How Nutrient Uptake Factors Changed Compared to the Site Control (APG-015).

Site	Uptake Factors (plant / soil concentration)											
	B	Ca	Cu	Fe	Mg	Mn	P	K	Na	S	Zn	N
APG-02	↑	↑	↑	--	↑	↑	↑	↑	--	--	↑	↓
APG-06	↑		↑	--	↑	--	↑	↑	--	--	↑	↑
APG-16	--	↑	--	--	↑	--	--	--	--	↓	--	--

Note: arrow indicates a statistical difference in uptake factor compared to the site control, while a dash (--) indicates no statistical change.

REFERENCES

Gorsuch, J.W., C.A. Staples, D. Brown, and R. Enste-Diefenbach. 2008. Vapor-phase toxicity of butylbenzyl phthalate to three plant species: white mustard, Chinese cabbage, and white clover. Bull. Environ. Contam. Toxicol. 81:220-224.

STATISTIX® 8. 2003. User's Manual. Analytical Software. Tallahassee, FL.

Walsh, G.E. 1991. Plant toxicity testing with sediment and marsh soils. Technical Report, NPS/NRWRD/NRTR-91/03. National Park Service, Water Resources Division.

WEST, Inc. and D.D. Gulley. 1996. Toxstat Version 3.5. Western EcoSystems Technology, Inc., Cheyenne, WY.

Statement of Procedural Compliance

I certify that this document and all attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of the person or persons who manage the system, or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge, accurate and complete.

January 9, 2013

Rami B. Naddy, Ph.D. Date
Study Director

Statement of Quality Assurance

The test data were reviewed by the Quality Assurance Unit to assure that the study was performed in accordance with the protocol and standard operating procedures. This report is an accurate reflection of the raw data.

Anita B. Rehner, Anita B. Rehner for Christina Needham January 9, 2013

Anita B. Rehner, M.S. Date
Quality Assurance Officer

APPENDIX A

Chains of Custody

ENSR | AECOM

CHAIN OF CUSTODY RECORD

Client/Project Name: AECOM - ESTCP Canal Creek Field Demonstration

Project Location: Aberdeen Proving Ground Edgewood, MD - Canal Creek

Project Number: 60133180

Field Logbook No.:

Sampler (Print Name)/(Affiliation): M. Russell, D. Smith / AECOM

Chain of Custody Tape Nos.: ~~Ryan~~ Not Used

Signature:

Send Results/Report to: Ryan McCarthy Ryan.McCarthy@aecom.com

TAT:

Analysis Requested: Plant Tissue

Container Type	Preservation
P – Plastic	1 – HCl, 4°
A – Amber Glass	2 – H2SO4, 4°
G – Clear Glass	3 – HNO3, 4°
V – VOA Vial	4 – NaOH, 4°
O – Other	5 – NaOH/ZnAc, 4°
E – Encore	6 – Na2S2O3, 4°
	7 – 4°

Matrix Codes:

DW – Drinking Water	S – Soil
WW – Wastewater	SL – Sludge
GW – Groundwater	SD – Sediment
SW – Surface Water	SO – Solid
ST – Storm Water	A – Air
W – Water	L – Liquid
	P – Product

Field Sample No./Identification	Date	Time	COMP	GRAB	Sample Container (Size/Mat'l)	Matrix	Preserv.	Field Filtered	Plant Tissue										Lab I.D.	Remarks (cooler temp D-53)
APG-06-MA-060311	6/3/11	1515		X	12" core	SD		NA	X										25060	, 14.1°C
APG-15-MA-060311	6/3/11	1605		X	12" core	SD		NA	X										25061	, 14.1°C
APG-02-MA-060311	6/3/11	1620		X	12" core	SD		NA	X										25062	, 14.1°C
APG-16-MA-060311	6/3/11	1630		X	12" core	SD		NA	X										25063	, 14.1°C

Relinquished by: (Print Name)/(Affiliation)	Date / Time	Received by: (Print Name)/(Affiliation)	Date / Time
Michele Russell AECOM Signature:	Date: 6/8/11 Time: 1500	Christina Needham for Emily Sodter/AECOM Signature: Christina Needham	Date: 6/9/11 Time: 1015
Relinquished by: (Print Name)/(Affiliation) Signature:	Date: Time:	Received by: (Print Name)/(Affiliation) Signature:	Date: Time:
Relinquished by: (Print Name)/(Affiliation) Signature:	Date: Time:	Received by: (Print Name)/(Affiliation) Signature:	Date: Time:

Analytical Laboratory (Destination): AECOM - Ft. Collins, CO

Received from FedEx on ice, cooler temps taken

Sample Shipped Via: UPS FedEx Courier Other

Temp blank: Yes No

Note: Received 4 12" cores from each site, containers only 1/2 full

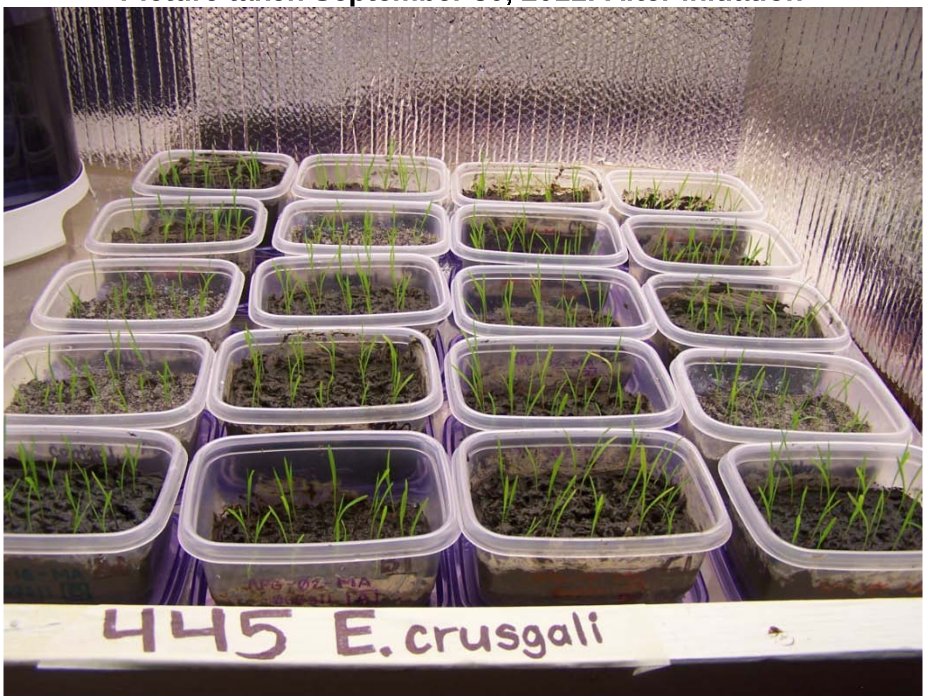
Cooler #10 -

APG 06MA - 060311	@1515		bag #1
APG 06MA			
APG 02MA	@1620		
APG 16MA	@1630		
APG 16MA	@1630		bag #2
APG 02MA	@1620		
APG 16MA	@1650		
APG 02MA	@1620		
APG 15MA	@1605		bag #3
APG 15MA	@1605		
APG 16MA	@1630		
APG 02MA	@1620		
APG 15MA	@1605		bag #4
APG 06MA	@1515		
APG 06MA	@1515		
APG 15MA	@1605		

APPENDIX B

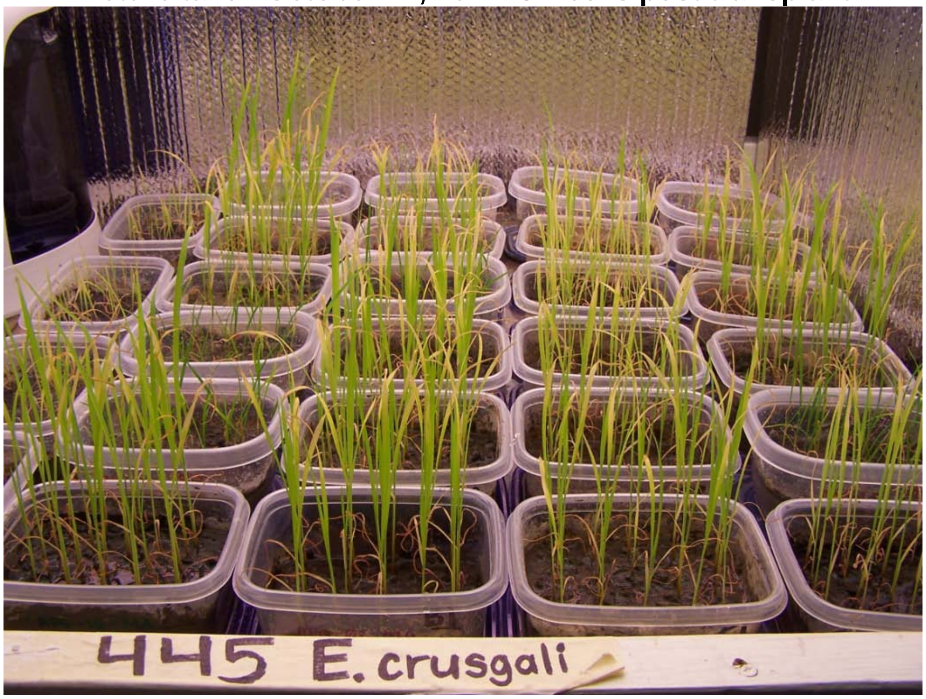
Photo Log

Picture taken September 30, 2011: After initiation



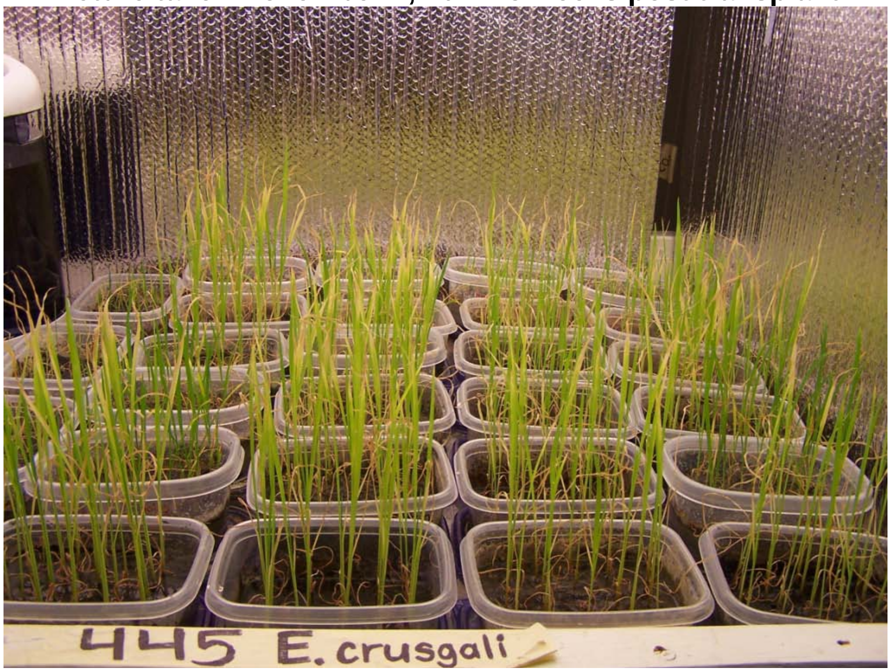
Picture taken October 7, 2011: One week after being transplanted

Picture taken October 21, 2011: 3 weeks post transplant



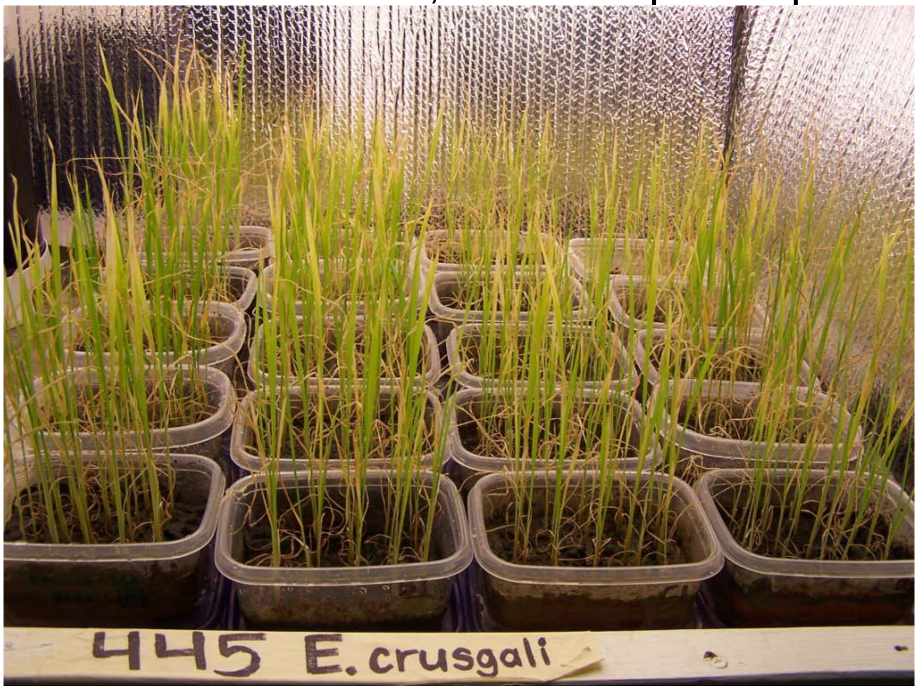
Picture taken October 28, 2011: 4 weeks post transplant

Picture taken November 4, 2011: 5 weeks post transplant

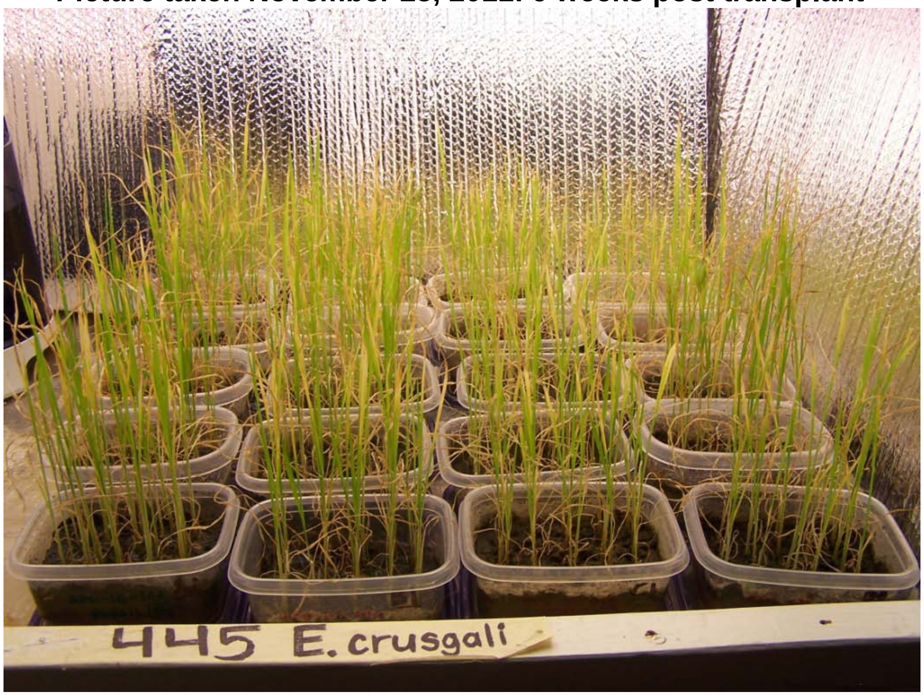


Picture taken November 14, 2011: 7 weeks post transplant

Picture taken November 18, 2011: 8 weeks post transplant

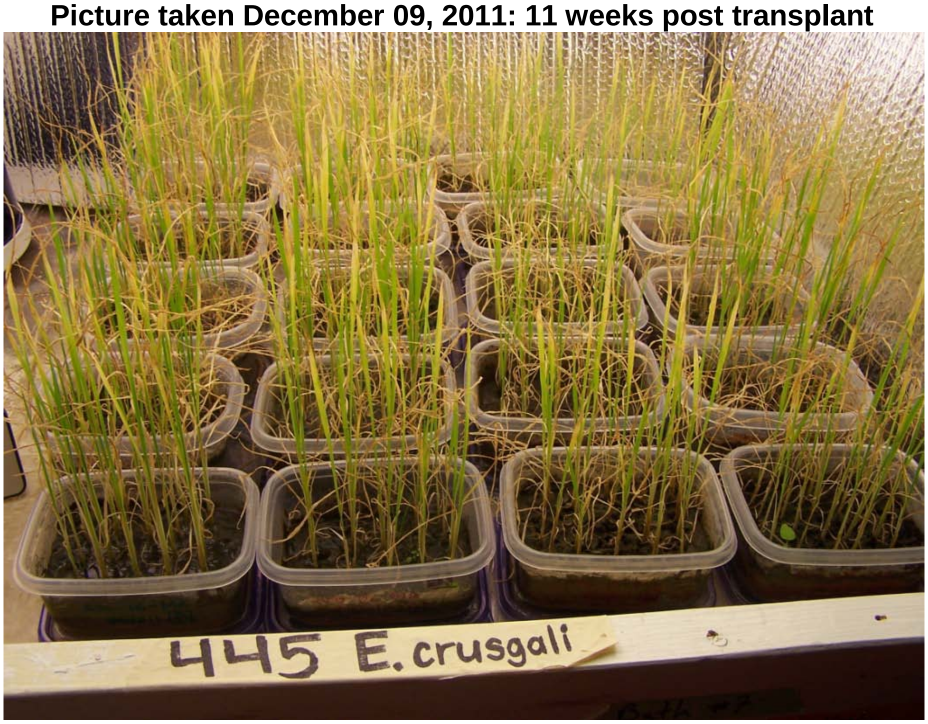


Picture taken November 25, 2011: 9 weeks post transplant



Picture taken December 02, 2011: 10 weeks post transplant

Picture taken December 09, 2011: 11 weeks post transplant



APPENDIX C

Analytical Data

COLUMBIA ANALYTICAL SERVICES, INC.
Now part of the ALS Group

Analytical Report

Client :	AECOM	**Service Request :**	K1200992
Project Name :	60225262-445	**Date Collected :**	02/01/12
Project No. :	1	**Date Received :**	02/02/12
Matrix :	Water	**Date Extracted :**	02/02/12

Total Metals

Sample Name :	Nutrients	**Units :**	ug/L (ppb)
Lab Code :	K1200992-001	**Basis :**	NA

Analyte	Analysis Method	MRL	Date Analyzed	Sample Result	Result Notes
Boron	200.7	50	02/03/12	ND	
Calcium	200.7	50	02/03/12	33900	
Copper	200.7	10	02/03/12	ND	
Iron	200.7	20	02/03/12	954	
Magnesium	200.7	20	02/03/12	4590	
Manganese	200.7	5.0	02/03/12	ND	
Phosphorus	200.7	200	02/03/12	11800	
Potassium	200.7	400	02/03/12	35000	
Sodium	200.7	200	02/03/12	ND	
Sulfur	200.7	100	02/03/12	7250	
Zinc	200.7	10	02/03/12	ND	

Comments:

COLUMBIA ANALYTICAL SERVICES, INC.
Now part of the ALS Group

Analytical Report

Client:	AECOM	**Service Request:**	K1201143
Project:	Nutrients/60147216-445	**Date Collected:**	02/6/12
Sample Matrix:	Water	**Date Received:**	02/7/12
Analysis Method:	353.2	**Units:**	mg/L
		Basis:	NA

Nitrate+Nitrite as Nitrogen

Sample Name	Lab Code	Result	MRL	Dil.	Date Analyzed	Q
Nutrients	K1201143-001	**28.5**	1.0	20	02/15/12 10:23	
Method Blank	K1201143-MB1	ND U	0.050	1	02/15/12 10:23	
Method Blank	K1201143-MB2	ND U	0.050	1	02/15/12 10:23	
Method Blank	K1201143-MB3	ND U	0.050	1	02/15/12 10:23	

COLUMBIA ANALYTICAL SERVICES, INC.
Now part of the ALS Group

Analytical Report

Client:	AECOM		**Service Request:**	K1201143
Project:	Nutrients/60147216-445		**Date Collected:**	02/6/12
Sample Matrix:	Water		**Date Received:**	02/7/12
Analysis Method:	ASTM D1426-93B		**Units:**	mg/L
Prep Method:	ASTM D 3590-89B-21.1		**Basis:**	NA

Nitrogen, Total Kjeldahl (TKN)

Sample Name	Lab Code	Result	MRL	Dil.	Date Analyzed	Date Extracted	Q
Nutrients	K1201143-001	**1.64**	0.40	2	02/10/12 02:10	2/9/12	
Method Blank	K1201143-MB1	ND U	0.20	2	02/10/12 02:10	2/9/12	

60225262-445
~~60225262-445~~ (1)

ESTCP Plant study-Soil Samples

KSN 6/26/12
QA: AR 06/26/12

filename: analytical summary_445.xlxs

			mg/kg dry weight basis											Dry Weight Basis		Initial	Final	Dry Weight Basis
Sample ID	Site	% Solids	B		Ca	Cu	Fe	Mg	Mn	P	K	Na		S	Zn	N %		pH	pH	TOC %
APG-02-MA060311	APG-02	25.5	3.8		2,170	245	14,800	1,360	253	809	294	121		5,050	895	1.27		6.1	5.03	14.4
APG-06-MA060311	APG-06	44.5	4.5		6,600	70.9	12,600	3,890	259	518	304	99		5,180	931	0.35		6.7	6.58	6.43
APG-15-MA060311	APG-15	33.3	5.5		29,600	869	19,100	5,440	338	1,050	542	246		10,400	5,330	0.80		7.0	7.15	15.5
APG-16-MA060311	APG-16	33.6	6.0		5,140	389	21,500	2,680	303	800	610	327		14,200	5,360	0.72		6.5	6.21	10.6
Control	Control	62.5	3.1	U	7,600	1.3	629	95.5	10.2	149	127	62.1	U	113	3.1	0.06	J	6.5	7.63	2.79

U = The analyte was analyzed for but not detected ("non-detect") at or above the MDL.

J = The result is an estimated value (result was between the MDL and MRL).

(1) GKM 07/19/12 C, late entry

60147216-
① ~~60225262~~-445 - 035-038

ESTCP Plant study-Plant Tissue

filename: analytical summary_445.xlxs

QA: AR 07/19/12

		"as received" basis (DRY), mg/kg											WET Basis
Sample ID	**Site**	**B**	**Ca**	**Cu**	**Fe**	**Mg**	**Mn**	**P**	**K**	**Na**	**S**	**Zn**	**N %**
APG-02-MA060311 A	APG-02	17.2	7,200	16.4	146	12,900	2,060	2,660	14,900	1,870	14,000	434	0.9
APG-02-MA060311 B	APG-02	15.3	6,770	13.2	348	10,700	1,160	2,310	16,100	1,240	13,200	345	0.97
APG-02-MA060311 C	APG-02	17.0	7,280	26.9	415	11,300	1,380	2,320	18,300	946	16,400	436	0.83
APG-02-MA060311 D	APG-02	28.5	22,400	26.2	91.3	12,700	2,370	1,920	17,300	6,260	32,400	1,870	0.81
	Average	19.50	10,912.50	20.68	250.08	11,900.00	1,742.50	2,302.50	16,650.00	2,579.00	19,000.00	771.25	0.88
	Standard Deviation	6.06	7,661.61	6.91	155.81	1,070.83	567.24	302.48	1,473.09	2,484.09	9,036.22	733.73	0.07
	CV	31.1%	70.2%	33.4%	62.3%	9.0%	32.6%	13.1%	8.8%	96.3%	47.6%	95.1%	8.3%

Sample ID	**Site**	**B**	**Ca**	**Cu**	**Fe**	**Mg**	**Mn**	**P**	**K**	**Na**	**S**	**Zn**	**N %**
APG-06-MA060311 A	APG-06	13.0	24,500	7.3	122	14,900	181	1,930	16,500	4,000	28,900	323	0.76
APG-06-MA060311 B	APG-06	11.3	9,410	5.3	281	11,300	427	2,040	19,900	727	15,600	162	0.82
APG-06-MA060311 C	APG-06	12.5	11,900	6.5	121	14,800	275	2,030	19,000	2,800	19,600	392	0.79
APG-06-MA060311 D	APG-06	11.3	9,170	9.1	169	14,800	880	2,360	16,500	1,690	19,400	326	0.78
	Average	12.025	13,745.00	7.05	173.25	13,950.00	440.75	2,090.00	17,975.00	2,304.25	20,875.00	300.75	0.785
	Standard Deviation	0.86	7,275.46	1.59	75.24	1,767.30	309.88	186.73	1,742.36	1,412.60	5,657.66	97.83	0.03
	CV	7.2%	52.9%	22.6%	43.4%	12.7%	70.3%	8.9%	9.7%	61.3%	27.1%	32.5%	3.7%

Sample ID	**Site**	**B**	**Ca**	**Cu**	**Fe**	**Mg**	**Mn**	**P**	**K**	**Na**	**S**	**Zn**	**N %**
APG-15-MA060311 A	APG-15	8.8	21,400	24.4	105	10,400	496	2,060	18,000	5,640	25,200	776	0.74
APG-15-MA060311 B	APG-15	6.9	23,600	11.4	61.7	9,340	342	2,090	18,300	3,490	23,600	287	0.77
APG-15-MA060311 C	APG-15	10.7	44,200	12.4	196	10,100	421	1,730	14,300	11,200	42,900	809	0.67
APG-15-MA060311 D	APG-15	9.6	39,600	14.0	97.0	10,500	437	1,780	16,300	4,370	36,800	530	0.74
	Average	9.00	32,200.00	15.55	114.93	10,085.00	424.00	1,915.00	16,725.00	6,175.00	32,125.00	600.25	0.73
	Standard Deviation	1.60	11,392.40	6.00	57.23	524.94	63.47	186.28	1,840.97	3,464.30	9,284.17	243.02	0.04
	CV	17.8%	35.4%	38.6%	49.8%	5.2%	15.0%	9.7%	11.0%	56.1%	28.9%	40.5%	5.8%

Sample ID	**Site**	**B**	**Ca**	**Cu**	**Fe**	**Mg**	**Mn**	**P**	**K**	**Na**	**S**	**Zn**	**N %**
APG-16-MA060311 A	APG-16	7.3	17,300	8.5	76.5	7,870	245	1,440	12,700	5,810	18,700	448	0.81
APG-16-MA060311 B	APG-16	9.7	17,000	10.5	185	8,040	666	1,730	18,700	5,520	18,200	979	0.69
APG-16-MA060311 C	APG-16	11.6	16,200	9.0	120	9,380	520	2,070	18,900	6,170	19,400	864	0.79
APG-16-MA060311 D	APG-16	11.9	15,800	10.3	53.5	8,380	618	1,790	14,600	3,700	19,800	1,200	0.77
	Average	10.13	16,575.00	9.58	108.75	8,417.50	512.25	1,757.50	16,225.00	5,050.00	19,025.00	872.75	0.765
	Standard Deviation	2.12	694.62	0.98	57.83	675.79	188.24	258.38	3,073.95	937.27	713.68	315.63	0.05
	CV	20.9%	4.2%	10.2%	53.2%	8.0%	36.7%	14.7%	18.9%	18.6%	3.8%	36.2%	6.9%

Sample ID	**Site**	**B**	**Ca**	**Cu**	**Fe**	**Mg**	**Mn**	**P**	**K**	**Na**	**S**	**Zn**	**N %**
Control A	CA	6.6	19,400	2.9	64.7	12,500	263	3,160	18,800	124	5,070	38.7	0.92
Control B	CB	6.0	19,800	2.4	51.0	10,200	203	2,760	14,400	88.6	4,600	34.6	0.93
Control C	CC	5.8	23,200	2.0	49.9	10,700	189	3,140	15,100	99.5	3,880	33.7	1.05
Control D	CD	6.3	16,600	1.8	41.8 X	10,400	167	2,440	14,700	84.4	3,440	25.0	0.83
	Average	6.18	19,750.00	2.28	51.85	10,950.00	205.50	2,875.00	15,750.00	99.13	4,247.50	33.00	0.93
	Standard Deviation	0.35	2,704.93	0.49	9.50	1,053.57	41.10	343.46	2,053.45	17.76	727.62	5.78	0.09
	CV	5.7%	13.7%	21.3%	18.3%	9.6%	20.0%	11.9%	13.0%	17.9%	17.1%	17.5%	9.7%

X = sample result is estimated because the value was found to be less than 20 times the amount found in the blank (2.4).

① GM 07/19/12 C

APPENDIX D

Biological Data

FCETL QA Form No. 115
Revision 0
Effective 8/99

SEDIMENT TOXICITY DATA PACKAGE COVER SHEET

Test Type: Chronic

Project Number: 60147216-445-(035-038) ★ 7/20/12 GMM 07/23/12

Test Substance: Sediment/soil

Species: *Echinochloa crusgalli*

Hydration Water Type: Milli-Q® and ~~Hoagland's Solution~~ modified Gorsuch's solution ①

Organism Lot or Batch Number: 092011 (Lot#95-~~096~~ 59) ①

Concurrent Control Overlying Water Type: NA

Age: 10 days (seedlings) Supplier: Wildlife industries

Date and Time Test Began: 9/30/11 @ 1330-1600

Date and Time Test Ended: 12/16/11 @ 0900 12/30/11 @ 1345

Protocol Number:

Investigator(s): ★/AMW/KB/R/AS/DM/★/MT

Background Information

Type of Test: Non-renewal

Renewal Frequency: NA

Test Temperature: 24±1°C Env. Chmbr/Bath #: 7

Test Chambers: plastic container 710 mL (24 oz)

Photoperiod: ~~16 h light : 8 h dark~~ continuous ①

Overlying Water Vol: NA

Light Intensity: 400 ±20 ft.-c

Sediment Vol.: 100 ml

Number of Replicates per Treatment: 4

Length of Test: ~~5~~ 11 weeks ②

Number of Organisms per Replicate: 20

Type of Food and Quantity per Chamber: 20 ml ~~Hoaglands~~ modified Gorsuch nutrient solution ①

Feeding Frequency: test days 0, 7, 14, 21, 28, & 35

Test Substance Characterization Parameters and Frequency: Hardness: NA Alkalinity: NA

Conductivity: NA NH3: NA Temp: daily DO: NA pH: Initial & final in soils

Test Concentrations (Volume:Volume): 0 (laboratory control sediment) and 100% of each test soil

Test Sediment(s) Sample Description: APG-06-MA-060311 (#25060), APG-15-MA-060311 (#25061), APG-02-MA-060311 (#25062), and APG-16-MA-060311 (#25063)

FCETL Sample #(s): 25060, 25061, 25062, and 25063

Agency Summary Sheet(s)?: NA

Reference Toxicant Data: Test Dates: 1/20/12 to 2/3/12	LC_{50} or IC_{25} (Circle): 4085 mg/L Cl⁻
Hist. 95% Control Limits: 2644 to 12110	Method for Determining Ref. Tox. Value: Linear Interpolation

Special Procedures and Considerations:
Control soil preparation listed on QA form 015. All soils hydrated to point roughly equivalent to test soils (by technician estimate).
All containers maintained at hydration levels close to that at test initation using ~~Hoaglands~~ modified Gorsuch nutrient ① solution on days 0, 7, 14, 21, & 28
and MQ on all other test days. All additions recorded on daily log.
Light Intensity: 397, 403, 361, 371, 404 x̄ = 388 (Day 0)
Study Director Initials: ★ Date: 9/30/11

①★ 7/23/12, E ② GMM Per ? 07/23/12

SEDIMENT/SOIL PREPARATION

60147216-445-(035-038) ~~AB~~ 2/20/12 GVM 07/23/12

Artificial soil	
Constituent/source	**Amount added (g)**
See Form : FCETL On Form No. 15 with this data pkg for preparation of artificial soil.	
Notes:	

Soil/sediment	Rep	FCETL#	Homogenization				
			Date	From	To	Notes / Approx wet wt.	Analyst[1]
Form. Sed	NA	N/A	09/29/11	~~0943~~[1] 1045	~~0946~~[1] 1050	Added Milli-Q ~500 each	~~AB~~
APG-06-MA-060311	A	25060	09/29/11	0943	0946	added milliQ ~543g	AB
APG-06-MA-060311	B	25060	09/29/11	0950	0953	added milliQ ~340g	AB
APG-06-MA-060311	C	25060	09/29/11	1000	1003	added milliQ ~525g - removal stick	AB
APG-06-MA-060311	D	25060	09/29/11	1007	1010	added milliQ ~560g	AB
APG-15-MA-060311	A	25061	09/29/11	1015	1020	~489g ~~~484g~~	[illegible]
APG-15-MA-060311	B	25061	09/29/11	1043	1046	~529g	
APG-15-MA-060311	C	25061	09/29/11	1027	1030	added milliQ ~555g	AB
APG-15-MA-060311	D	25061	09/29/11	1052	1055	~484g ~~~560~~	AB
APG-02-MA-060311	A	25062	09/29/11	0940	0943	removed root / ~216g	[illegible]
APG-02-MA-060311	B	25062	09/29/11	0947	0952	~343g	[illegible]
APG-02-MA-060311	C	25062	09/29/11	0955	1000	~345g	[illegible]
APG-02-MA-060311	D	25062	09/29/11	1005	1010	~333g	[illegible]
APG-16-MA-060311	A	25063	09/29/11	0936	0939	~556g	CW
APG-16-MA-060311	B	25063	09/29/11	0950	0953	~541g	CW
APG-16-MA-060311	C	25063	09/29/11	0957	1001	~566g	CW
APG-16-MA-060311	D	25063	09/29/11	1007	1011	~534g	CW

(1) AB 9/29/11 UP
(2) CW 09/29/11 WP

FCETL QA Form No. 069
Revision 1
Effective 06/93

SEED GERMINATION BIOLOGICAL DATA

*7/20/12
GWM 07/23/12

Project Number: 60147216-445- (035-038)	
Test Species (Circle): *Lactuca sativa*	Other (Specify): ***E. crusgalli***

Conc.	Test Replicate	Initial Number of Seedlings	Number of Surviving Seedlings Day 1	Number of Surviving Seedlings Day 2	Number of Surviving Seedlings Day 3	Number of Surviving Seedlings Day 4	Number of Surviving Seedlings Day 5
0	A	20	20	20	20	20	20
	B	20	20	20 ①	20	20	20
	C	20	20	20	20	20	20
	D	20	20	20	20	20	20
APG-06-MA-060311	A	20	20	20	20	20	20
	B	20	20	20	20	20	20
	C	20	20	20	20	20	20
	D	20	20	20	20	20	20
APG-15-MA-060311	A	20	20	20	20	20	20
	B	20	20	20	20	20	20
	C	20	20	20	20	20	20
	D	20	20	20	20	20	20
APG-02-MA-060311	A	20	20	20	20	20	20
	B	20	20	20	20	20	20
	C	20	20	20	20	20	20
	D	20	20	20	20	20	20
APG-16-MA-060311	A	20	20	20	20	20	20
	B	20	20	20	20	20	20
	C	20	20	20	20	20	20
	D	20	20	20	20	20	20
	Date:	9/30/11	10/1/11	10/2/11	10/3/11	10/4/11	10/5/11
	Time:	1330-1600	0930	1030	1510	1515	0830
	Initials:	[illegible]	AM	AM	AM	[illegible]	[illegible]

① *7/23/12, cf - new control plants were initiated on day 14, with original seedlings (see pg 5)

SEED GERMINATION BIOLOGICAL DATA

*7/20/12
GLM 07/23/12

Project Number: 60147216-445- (035-038)

Test Species (Circle): *Lactuca sativa* Other (Specify): ***E. crusgalli***

Conc.	Test Replicate	Number of Surviving Seedlings Day 6	Number of Surviving Seedlings Day 7	Number of Surviving Seedlings Day 8	Number of Surviving Seedlings Day 9	Number of Surviving Seedlings Day 10	Number of Surviving Seedlings Day 11
0	A	~~20 *~~	~~20 *~~	~~20 *~~	~~20~~	~~20 *~~	~~20 *~~
	B	~~20 *~~	~~20 *~~	~~20 *~~	① ~~20~~	~~20 *~~	~~20 *~~
	C	~~20 *~~	~~20 *~~	~~20 *~~	~~20~~	~~20 *~~	~~20 *~~
	D	~~20 *~~	~~20 *~~	~~20 *~~	~~20~~	~~20 *~~	~~20 *~~
APG-06-MA-060311	A	20	20	20	20	20	20
	B	20	20	20	20	20	20
	C	20	20	20	20	20	20
	D	20	20	20	20	20	20
APG-15-MA-060311	A	20	20	20	20	20	20
	B	20	20	20	20	20	20
	C	20	20	20	20	20	20
	D	20	20	20	20	20	20
APG-02-MA-060311	A	20	20	20	20	20	20
	B	20	20	20	20	20	20
	C	20	20	20	20	20	20
	D	20	20	20	20	20	20
APG-16-MA-060311	A	20	20	20	20	20	20
	B	20	20	20	20	20	20
	C	20	20	20	20	20	20
	D	20	20	20	20	20	20
	Date:	10/6/11	10/7/11	10/8/11	10/9/11	10/10/11	10/11/11
	Time:	1040	0930	0940	1005	1730	1500
	Initials:	[illegible]	[illegible]	KB	KB	[illegible]	[illegible]

* plants yellowing/browning

① *7/23/12, NA - new control plants were initiated on Day 14 with original seedlings. (see page 5)

SEED GERMINATION BIOLOGICAL DATA

gum 07/23/12

Project Number: 60147216-445- (035-038)	
Test Species (Circle): *Lactuca sativa* Other (Specify): ***E. crusgalli***	

Conc.	Test Replicate	Number of Surviving Seedlings Day 12	Number of Surviving Seedlings Day 13	Number of Surviving Seedlings Day 14	Number of Surviving Seedlings Day 15	Number of Surviving Seedlings Day 16	Number of Surviving Seedlings Day 17
0	A			20	20	20	20
	B			20	20	20	20
	C	①	①	20	20	20	20
	D			20	20	20	20
	Date:			10/14/11	10/15/~~12~~ 11 ②	10/16/11	10/17/~~12~~ 11 ②
	Time:	①	①	1630	1000	0910	1545
	Initials:			AR	AR for BP	AB	FK

① AR 7/6/12, NA
② FK 7/23/12, NA

Notes: New control replicates (n=4) were initiated on Day 14 with original seedlings.

SEED GERMINATION BIOLOGICAL DATA

7/20/12
07/23/12

Project Number: 60147216-445-(035-038)

Test Species (Circle): *Lactuca sativa* Other (Specify): ***E. crusgalli***

Conc.	Test Replicate	Number of Surviving Seedlings Day 12	Number of Surviving Seedlings Day 13	Number of Surviving Seedlings Day 14	Number of Surviving Seedlings Day 15	Number of Surviving Seedlings Day 16	Number of Surviving Seedlings Day 17
0	A	① 20 *	① 20 *	② 20 *	20*	20*	20
	B	20 *	20 *	20 *	20*	20 * ③	20
	C	20 *	20 *	20 *	20*	20 *	20
	D	20 *	20 *	20 *	20 *	20 *	20
APG-06-MA-060311	A	20	20	20	20	20	20
	B	20	20	20	20	20	20
	C	20	20	20	20	20	20
	D	20	20	20	20	20	20
APG-15-MA-060311	A	20	20	20	20	20	20
	B	20	20	20	20	20	20
	C	20	20	20	20	20	20
	D	20	20	20	20	20	20
APG-02-MA-060311	A	20	20	20	20	20	20
	B	20	20	20	20	20	20
	C	20	20	20	20	20	20
	D	20	20	20	20	20	20
APG-16-MA-060311	A	20	20	20	20	20	20
	B	20	20	20	20	20	20
	C	20	20	20	20	20	20
	D	20	20	20	20	20	20
	Date:	10/12/11	10/13/11	10/14/11	10/15/11	10/16/11	10/17/11
	Time:	0840	1630	1000	1000	0910	1545
	Initials:	KB	[illegible]	TK	BP	[illegible]	TK

* plants yellowing/browning

① 7/23/12, N/A - new control plants were initiated on day 14.
② 7/23/12, New control plants were initiated in PM on day 14.
③ 7/23/12, Cf - see previous page for control biological data.
④ 7/23/12, E

SEED GERMINATION BIOLOGICAL DATA

ak 7/23/12
GXM 07/23/12

Project Number: 60147216-445- (035-038)	
Test Species (Circle): *Lactuca sativa* Other (Specify): ***E. crusgalli***	

Conc.	Test Replicate	Number of Surviving Seedlings Day 18	Number of Surviving Seedlings Day 19	Number of Surviving Seedlings Day 20	Number of Surviving Seedlings Day 21	Number of Surviving Seedlings Day 22	Number of Surviving Seedlings Day 23
0	A	20	20	20	20	20	20
	B	20	20	20	20	20	20
	C	20	20	20	20	20	20
	D	20	20	20	20	20	20
	Date:	10/18/11	10/19/11	10/20/11	10/21/11	10/22/11	10/23/11
	Time:	0900	0845	1600	1000	1540	1520
	Initials:	AB	KB	TK	ak	TK	TK

FCETL QA Form No. 069
Revision 1
Effective 06/93

SEED GERMINATION BIOLOGICAL DATA

✱ 7/20/12
GKM 07/23/12

Project Number: 60147216-445-(035-038)	
Test Species (Circle): *Lactuca sativa*	Other (Specify): ***E. crusgalli***

Conc.	Test Replicate	Number of Surviving Seedlings Day 18	Number of Surviving Seedlings Day 19	Number of Surviving Seedlings Day 20	Number of Surviving Seedlings Day 21	Number of Surviving Seedlings Day 22	Number of Surviving Seedlings Day 23
0	A	20*	20 *	20 *	20	20 *	20
	B	20*	20 *	20 *	20 ②	20 *	20
	C	20*	20 *	20 *	20	20 *	20
	D	20*	20 *	20 *	20	20 *	20
APG-06-MA-060311	A	20	20	20	20	20	20
	B	20	20	20	20	20	20
	C	20	20	20	20	20	20
	D	20	20	20	20	20	20
APG-15-MA-060311	A	20	20	20	20	20	20
	B	20	20	20	20	20	20
	C	20	20	20	20	20	20
	D	20	20	20	20	20	20
APG-02-MA-060311	A	20	20	20	20	20	20
	B	20	20	20	20	20	20
	C	20	20	20	20	20	20
	D	20	20	20	20	20	20
APG-16-MA-060311	A	20	20	20	20	20	20
	B	20	20	20	20	20	20
	C	20	20	20	20	20	20
	D	20	20	20	20	20	20
	Date:	10/18/11	10/19/11	10/20/11	10/21/11	10/22/11	10/23/11
	Time:	0900	0845	1600	1000	1540	1520
	Initials:	AB	AB	K	[illegible]	K	K

*20 plants yellowing/browning

① ✱ 7/23/12, E
② ✱ 7/23/12, Cf - see previous page for control Biological data.

FCETL QA Form No. 069
Revision 1
Effective 06/93

SEED GERMINATION BIOLOGICAL DATA

7/23/12
GMM 07/23/12

Project Number: 60147216-445- (035-038)

Test Species (Circle): *Lactuca sativa* Other (Specify): ***E. crusgalli***

Conc.	Test Replicate	Number of Surviving Seedlings Day 24	Number of Surviving Seedlings Day 25	Number of Surviving Seedlings Day 26	Number of Surviving Seedlings Day 27	Number of Surviving Seedlings Day 28	Number of Surviving Seedlings Day 29
0	A	20	20	20	20	20	20
	B	20	20	20	20	20	20
	C	20	20	20	20	20	20
	D	20	20	20	20	20	20
	Date:	10/24/11	10/25/11	10/26/12	10/27/11	10/28/11	10/29/11
	Time:	1125	1435	unk	1600	1105	0930
	Initials:	AB	DM	GMM AMK	TK	DM	KB

FCETL QA Form No. 069
Revision 1
Effective 06/93

SEED GERMINATION BIOLOGICAL DATA

~~*7/20/12~~ GMM 07/23/12

Project Number: 60147216-445- (035-038)	
Test Species (Circle): *Lactuca sativa*	Other (Specify): ***E. crusgalli***

Conc.	Test Replicate	Number of Surviving Seedlings Day 24	Number of Surviving Seedlings Day 25	Number of Surviving Seedlings Day 26	Number of Surviving Seedlings Day 27	Number of Surviving Seedlings Day 28	Number of Surviving Seedlings Day 29
0	A	~~20*~~	~~20*~~	~~20~~	~~20~~	~~20~~	~~20~~
	B	~~20*~~	~~20*~~	~~20~~	[2] ~~20~~	~~20~~	~~20~~
	C	~~20*~~	~~20*~~	~~20~~	~~20~~	~~20~~	~~20~~
	D	~~20*~~	~~20*~~	~~20~~	~~20~~	~~20~~	~~20~~
APG-06-MA-060311	A	20	20	20	20	20	20
	B	20	20	20	20	20	20
	C	20	20	20	20	20	20
	D	20	20	20	20	20	20
APG-15-MA-060311	A	20	20	20	20	20	20
	B	20	20	20	20	20	20
	C	20	20	20	20	20	20
	D	20	20	20	20	20	20
APG-02-MA-060311	A	20	20	20	20	20	20
	B	20	20	20	20	20	20
	C	20	20	20	20	20	20
	D	20	20	20	20	20	20
APG-16-MA-060311	A	20	20	20	20	20	20
	B	20	20	20	20	20	20
	C	20	20	20	20	20	20
	D	20	20	20	20	20	20
	Date:	10/24/11	10/25/11	10/26/12	10/27/11	10/28/11	10/29/11
	Time:	1125	1435	unk	1600	1105	0930
	Initials:	AB	DM	GMM for MMR	TG	DM	KB

*plants yellow/browning

[1] *7/23/12, E
[2] *7/23/12, CF - see previous page for control biological data.

SEED GERMINATION BIOLOGICAL DATA

★ 7/23/12
GUM 07/23/12

Project Number: 60147216-445- (035-038)	
Test Species (Circle): *Lactuca sativa* Other (Specify): ***E. crusgalli***	

Conc.	Test Replicate	Number of Surviving Seedlings Day 30	Number of Surviving Seedlings Day 31	Number of Surviving Seedlings Day 32	Number of Surviving Seedlings Day 33	Number of Surviving Seedlings Day 34	Number of Surviving Seedlings Day 35
0	A	20	20	20	20	20	20
	B	20	20	20	20	20	20
	C	20	20	20	20	20	20
	D	20	20	20	20	20	20
	Date:	10/30/11	10/31/1~~2~~1 ①	11/1/11	11/2/11	11/3/11	11/4/1~~2~~1 ①
	Time:	1045	0845	0850	1100	1600	1100
	Initials:	KB	★ for BP	AB	★	KB	★

① ★ 7/23/12, E

Page ~~8~~ 12 of 71
FCETL QA Form No. 069
Revision 1
Effective 06/93

SEED GERMINATION BIOLOGICAL DATA

7/20/12
07/23/12

Project Number: 60147216-445-(035-038)

Test Species (Circle): *Lactuca sativa* Other (Specify): ***E. crusgalli***

Conc.	Test Replicate	Number of Surviving Seedlings Day 30	Number of Surviving Seedlings Day 31	Number of Surviving Seedlings Day 32	Number of Surviving Seedlings Day 33	Number of Surviving Seedlings Day 34	Number of Surviving Seedlings Day 35
0	A	20	20	20	20	20	20
	B	20	20	20 ②	20	20	20
	C	20	20	20	20	20	20
	D	20	20	20	20	20	20
APG-06-MA-060311	A	20	20	20	20	20	20
	B	20	20	20	20	20	20
	C	20	20	20	20	20	20
	D	20	20	20	20	20	20
APG-15-MA-060311	A	20	20	20	20	20	20
	B	20	20	20	20	20	20
	C	20	20	20	20	20	20
	D	20	20	20	20	20	20
APG-02-MA-060311	A	20	20	20	20	20	20
	B	20	20	20	20	20	20
	C	20	20	20	20	20	20
	D	20	20	20	20	20	20
APG-16-MA-060311	A	20	20	20	20	20	20
	B	20	20	20	20	20	20
	C	20	20	20	20	20	20
	D	20	20	20	20	20	20
	Date:	10/30/11	10/31/11	11/1/11	11/2/11	11/3/11	11/4/11
	Time:	1045	0845	0850	1100	1000	1100
	Initials:	KB	BP	[illegible]	[illegible]	KB	[illegible]

① 7/23/12, E
② 7/23/12, cf - see previous page for control Biological data.

FCETL QA Form No. 069
Revision 1
Effective 06/93

SEED GERMINATION BIOLOGICAL DATA

AK 7/23/12
GMM 07/23/12

Project Number: 60147216-445-(035-038)

Test Species (Circle): *Lactuca sativa* Other (Specify): ***E. crusgalli***

Conc.	Test Replicate	Number of Surviving Seedlings Day 36	Number of Surviving Seedlings Day 37	Number of Surviving Seedlings Day 38	Number of Surviving Seedlings Day 39	Number of Surviving Seedlings Day 40	Number of Surviving Seedlings Day 41
0	A	20	20	20	20	20	20
	B	20	20	20	20	20	20
	C	20	20	20	20	20	20
	D	20	20	20	20	20	20
	Date:	11/5/11	11/6/11	11/7/11	11/08/11	11/9/11	11/10/11
	Time:	0940	1030	1125	0945	1535	0900
	Initials:	AK for BP	AK for BP	MT	AK for BP	TK	AK for BP

SEED GERMINATION BIOLOGICAL DATA

Ⓐ 7/20/12
6mm 07/23/12

Project Number: 60147216-445- (035-0390)

Test Species (Circle): *Lactuca sativa* Other (Specify): ***E. crusgalli***

Conc.	Test Replicate	Number of Surviving Seedlings Day 36	Number of Surviving Seedlings Day 37	Number of Surviving Seedlings Day 38	Number of Surviving Seedlings Day 39	Number of Surviving Seedlings Day 40	Number of Surviving Seedlings Day 41
0	A	~~20~~	~~20~~	20	20	20	20
	B	20	20	~~20~~	~~20~~	20	20
	C	20	20	20	~~20~~	~~20~~	20
	D	20	20	20	20	20	~~20~~
APG-06-MA-060311	A	20	20	20	20	20	20
	B	20	20	20	20	20	20
	C	20	20	20	20	20	20
	D	20	20	20	20	20	20
APG-15-MA-060311	A	20	20	20	20	20	20
	B	20	20	20	20	20	20
	C	20	20	20	20	20	20
	D	20	20	20	20	20	20
APG-02-MA-060311	A	20	20	20	20	20	20
	B	20	20	20	20	20	20
	C	20	20	20	20	20	20
	D	20	20	20	20	20	20
APG-16-MA-060311	A	20	20	20	20	20	20
	B	20	20	20	20	20	20
	C	20	20	20	20	20	20
	D	20	20	20	20	20	20
	Date:	11/5/11	11/6/11	11/7/11	11/8/11	11/9/11	11/10/11
	Time:	0940	1030	1125	0945	1535	0900
	Initials:	BP	BP	mt	BP	R	BP

① Ⓐ 7/23/12, E
② Ⓐ 7/23/12, cf - see previous page for control biological data

SEED GERMINATION BIOLOGICAL DATA

ke 7/23/12
GLM 07/23/12

Project Number: 60147216-445- (035-038)

Test Species (Circle): *Lactuca sativa* Other (Specify): ***E. crusgalli***

Conc.	Test Replicate	Number of Surviving Seedlings Day 42	Number of Surviving Seedlings Day 43	Number of Surviving Seedlings Day 44	Number of Surviving Seedlings Day 45	Number of Surviving Seedlings Day 46	Number of Surviving Seedlings Day 47
0	A	20	20	20	20	20	20
	B	20	20	20	20	20	20
	C	20	20	20	20	20	20
	D	20	20	20	20	20	20
	Date:	11/11/11	11/12/11	11/13/11	11/14/11	11/15/11	11/16/11
	Time:	0910	1000	1000	1015	1430	0830
	Initials:	KB	ke for AMR	ke for AMR	ke	K	ke for BP

SEED GERMINATION BIOLOGICAL DATA

07/20/12
GM 07/23/12

Project Number: 60147216-445- *(035-038)*	
Test Species (Circle): *Lactuca sativa* Other (Specify): ***E. crusgalli***	

Conc.	Test Replicate	Number of Surviving Seedlings Day 42	Number of Surviving Seedlings Day 43	Number of Surviving Seedlings Day 44	Number of Surviving Seedlings Day 45	Number of Surviving Seedlings Day 46	Number of Surviving Seedlings Day 47
0	A	20	20	20	20	20	20
	B	20	20	20 ③	20	20	20
	C	20	20	20	20	20	20
	D	20	20	20	20	20	20
APG-06-MA-060311	A	20	20	20	20	20	20
	B	20	20	20	20	20	20
	C	20	20	20	20	20	20
	D	20	20	20	20	20	20
APG-15-MA-060311	A	20	20	20	20	20	20
	B	20	20	20	20	20	20
	C	20	20	20	20	20	20
	D	20	20	20	20	20	20
APG-02-MA-060311	A	20	20	20	20	20	20
	B	20	20	20	20	20	20
	C	20	20	20	20	20	20
	D	20	20	20	20	20	20
APG-16-MA-060311	A	20	20	20	20	20	20
	B	20	20	20	20	20	20
	C	20	20	20	20	20	20
	D	20	20	20	20	20	20
	Date:	11/11/11	11/12/11	11/13/11	11/14/11 ①	11/15/11	11/16/11
	Time:	0910	1000	1000	1015	1430	0830
	Initials:	KB	An	An	[illegible]	TK	BP

② 07/23/12, E
③ 07/23/12, CF - see previous page for control biological data.

① 11/14/11, E

SEED GERMINATION BIOLOGICAL DATA

dp 7/23/12
Gam 07/23/12

Project Number: 60147216-445- (035-038)	
Test Species (Circle): *Lactuca sativa* Other (Specify): ***E. crusgalli***	

Conc.	Test Replicate	Number of Surviving Seedlings Day 48	Number of Surviving Seedlings Day 49	Number of Surviving Seedlings Day 50	Number of Surviving Seedlings Day 51	Number of Surviving Seedlings Day 52	Number of Surviving Seedlings Day 53
0	A	20	20	20	20	20	20
	B	20	20	20	20	20	20
	C	20	20	20	20	20	20
	D	20	20	20	20	20	20
	Date:	11/17/11	11/18/11	11/19/11	11/20/11	11/21/11	11/22/12
	Time:	0845	0900	1345	0900	0830	0900
	Initials:	TK	dp for BP	TK	TK	TK	dp for AMc

SEED GERMINATION BIOLOGICAL DATA

~~7/20/12~~
GM 07/23/12

Project Number: 60147216-445-(0335-0350)

Test Species (Circle): *Lactuca sativa* Other (Specify): ***E. crusgalli***

Conc.	Test Replicate	Number of Surviving Seedlings Day 48	Number of Surviving Seedlings Day 49	Number of Surviving Seedlings Day 50	Number of Surviving Seedlings Day 51	Number of Surviving Seedlings Day 52	Number of Surviving Seedlings Day 53
0	A	20	20	20	20	20	20
	B	20	20	20	② 20	20	20
	C	20	20	20	20	20	20
	D	20	20	20	20	20	20
APG-06-MA-060311	A	20	20	20	20	20	20
	B	20	20	20	20	20	20
	C	20	20	20 ▲	20 ▲	20 ▲	20 ▲
	D	20	20	20	20	20	20
APG-15-MA-060311	A	20	20	20	20	20	20
	B	20	20	20	• 21 *	• 21 *	• 21 *
	C	20	20	20	20	20	20
	D	20	20	20	20	20	20
APG-02-MA-060311	A	20	20 ▲	20 ▲	20 ▲	20 ▲	20 ▲
	B	20	20 ▲	20 ▲	20 ▲	20 ▲	20 ▲
	C	20	20	20 ▲	20 ▲	20 ▲	20 ▲
	D	20	20	20	20	20	20
APG-16-MA-060311	A	20	20	20	20	20	20
	B	20	20	20	20	20	20
	C	20	20	20	20	20	20
	D	20	20	20	20	20	20
	Date:	11/17/11	11/18/11	11/19/11	11/20/11	11/21/11	11/22/11
	Time:	0845	0900	1345	0900	0830	0900
	Initials:	K	BP	K	K	K	AM

▲ green growth on top layer of soil

• additional plant is thought to be an indigenous species.

* new shoot coming through

① 7/23/12, E

② 7/23/12, ef see previous page for control biological data.

FCETL QA Form No. 069
Revision 1
Effective 06/93

SEED GERMINATION BIOLOGICAL DATA

AK 7/23/12
GLM 07/23/12

Project Number: 60147216-445- (035-038)

Test Species (Circle): *Lactuca sativa* Other (Specify): ***E. crusgalli***

Conc.	Test Replicate	Number of Surviving Seedlings Day 54	Number of Surviving Seedlings Day 55	Number of Surviving Seedlings Day 56	Number of Surviving Seedlings Day 57	Number of Surviving Seedlings Day 58	Number of Surviving Seedlings Day 59
0	A	20	20	20	20	20	20
	B	20	20	20	20	20	20
	C	20	20	20	20	20	20
	D	20	20	20	20	20	20
	Date:	11/23/11	11/24/~~10~~ 11	11/25/11	11/26/11	11/27/11	11/~~28~~/11
	Time:	1000	1000	1430	0930	0930	0930
	Initials:	KB	AP for BP	AP for BP	TK	TK	KB

AK 7/23/12, E

FCETL QA Form No. 069
Revision 1
Effective 06/93

SEED GERMINATION BIOLOGICAL DATA

JK 7/20/12
GMM 7/23/12

Project Number: 60147216-445- (035-038)

Test Species (Circle): *Lactuca sativa* Other (Specify): ***E. crusgalli***

Conc.	Test Replicate	Number of Surviving Seedlings ① Day ~~66~~ 534	Number of Surviving Seedlings ① Day ~~67~~ 545	Number of Surviving Seedlings ① Day ~~68~~ 556	Number of Surviving Seedlings ① Day ~~69~~ 567	Number of Surviving Seedlings ① Day ~~70~~ 578	Number of Surviving Seedlings ① Day ~~71~~ 589
0	A	20	20	20	20	20	20
	B	20	20	20 ③	20	20	20
	C	20	20	20	20	20	20
	D	20	20	20	20	20	20
APG-06-MA-060311	A	20	20	20	20	20	20
	B	20	20	20	20	20	20
	C	20	20	20	20	20	20
	D	20	20	20	20	20	20
APG-15-MA-060311	A	20	20	20	20	20	20
	B	20	20	20	20	20	20
	C	20	20	20	20	20	20
	D	20	20	20	20	20	20
APG-02-MA-060311	A	20	20	20	20	20	20
	B	20	20	20	20	20	20
	C	20	20	20	20	20	20
	D	20	20	20	20	20	20
APG-16-MA-060311	A	20	20	20	20	20	20
	B	20	20	20	20	20	20
	C	20	20	20	20	20	20
	D	20	20	20	20	20	20
	Date:	11/23/11	11/24/11	11/25/11	11/26/11	11/27/11	11/28/11
	Time:	1000	1000	1430	0930	0930	0930
	Initials:	KB	BP	BP	TK	TK	KB

① JK 12/5/11 E
② JK 7/23/12, E
③ JK 7/23/12, CF - see previous page for control biological data.

SEED GERMINATION BIOLOGICAL DATA

7/23/12
GMM 07/23/12

Project Number: 60147216-445- (035-038)

Test Species (Circle): *Lactuca sativa* Other (Specify): ***E. crusgalli***

Conc.	Test Replicate	Number of Surviving Seedlings Day 60	Number of Surviving Seedlings Day 61	Number of Surviving Seedlings Day 62	Number of Surviving Seedlings Day 63	Number of Surviving Seedlings Day 64	Number of Surviving Seedlings Day 65
0	A	20	20	20	20	20	20
	B	20	20	20	20	20	20
	C	20	20	20	20	20	20
	D	20	20	20	20	20	20
	Date:	11/29/11	11/30/11	12/1/11	12/2/11	12/3/11	12/4/11
	Time:	0900	0915	0940	0900	1130	1100
	Initials:	for BP	for BP	for BP		for AMR	for AMR

FCETL QA Form No. 069
Revision 1
Effective 06/93

SEED GERMINATION BIOLOGICAL DATA

~~&~~ 7/20/12
bmm 07/23/12

Project Number: 60147216-445-(035-038)

Test Species (Circle): *Lactuca sativa* Other (Specify): ***E. crusgalli***

Conc.	Test Replicate	Number of Surviving Seedlings ① Day ~~72~~ ~~59~~ 60	Number of Surviving Seedlings ① Day ~~73~~ 61	Number of Surviving Seedlings ① Day ~~74~~ 62	Number of Surviving Seedlings ① Day ~~75~~ 63	Number of Surviving Seedlings ① Day ~~76~~ 64	Number of Surviving Seedlings ① Day ~~77~~ ~~66~~ 65
0	A	20	20	20	20	20	20
	B	20	20	20 ③	20	20	20
	C	20	20	20	20	20	20
	D	20	20	20	20	20	20
APG-06-MA-060311	A	20	20	20	20	20	20
	B	20	20	20	20	20	20
	C	20	20	20	20	20	20
	D	20	20	20	20	20	20
APG-15-MA-060311	A	20	20	20	20	20	20
	B	20	20	20	20	20	20
	C	20	20	20	20	20	20
	D	20	20	20	20	20	20
APG-02-MA-060311	A	20	20	20	20	20	20
	B	20	20	20	20	20	20
	C	20	20	20	20	20	20
	D	20	20	20	20	20	20
APG-16-MA-060311	A	20	20	20	20	20	20
	B	20	20	20	20	20	20
	C	20	20	20	20	20	20
	D	20	20	20	20	20	20
	Date:	11/29/11	11/30/11	12/1/11	12/2/12 ① 11	12/3/11	12/4/11
	Time:	0900	0916	0940	0900	1130	1100
	Initials:	BP	BP	BP	&	Am	Am

① & 12/5/11 E
② & 7/23/12, E
③ & 7/23/12, CF - see previous page for control biological data.

FCETL QA Form No. 069
Revision 1
Effective 06/93

SEED GERMINATION BIOLOGICAL DATA

AC 7/23/12
GKM 07/23/12

Project Number: 60147216-445-(035-038)

Test Species (Circle): *Lactuca sativa* Other (Specify): ***E. crusgalli***

Conc.	Test Replicate	Number of Surviving Seedlings Day 66	Number of Surviving Seedlings Day 67	Number of Surviving Seedlings Day 68	Number of Surviving Seedlings Day 69	Number of Surviving Seedlings Day 70	Number of Surviving Seedlings Day 71
0	A	20	20	20	20	20	20
	B	20	20	20	20	20	20
	C	20	20	20	20	20	20
	D	20	20	20	20	20	20
	Date:	12/5/11	12/6/11	12/7/11	12/8/11	12/9/11	12/10/11
	Time:	1700	0830	0930	0900	1155	1156
	Initials:	AC	TK	~~AC~~ GKM AMR	AB	TK	KB

FCETL QA Form No. 069
Revision 1
Effective 06/93

SEED GERMINATION BIOLOGICAL DATA

7/20/12
GKM 07/23/12

Project Number: 60147216-445- (035-036)

Test Species (Circle): *Lactuca sativa* Other (Specify): ***E. crusgalli***

Conc.	Test Replicate	Number of Surviving Seedlings Day 66	Number of Surviving Seedlings Day 67	Number of Surviving Seedlings Day 68	Number of Surviving Seedlings Day 69	Number of Surviving Seedlings Day 70	Number of Surviving Seedlings Day 71
0	A	20	20	20	20	20	20
	B	20	20	20 ②	20	20	20
	C	20	20	20	20	20	20
	D	20	20	20	20	20	20
APG-06-MA-060311	A	19 *	19	19	19	19	19
	B	20	20	20	20	20	20
	C	20	20	20	20	20	20
	D	20	20	20	20	20	20
APG-15-MA-060311	A	19 *	19	19	19	19	19
	B	20	20	20	20	20	20
	C	20	20	20	20	20	20
	D	20	20	20	20	20	20
APG-02-MA-060311	A	19 *	19	19	19	19	19
	B	20	20	20	20	20	20
	C	20	20	20	20	20	20
	D	20	20	20	20	20	20
APG-16-MA-060311	A	19 *	19	19	19	19	19
	B	20	20	20	20	20	20
	C	20	20	20	20	20	20
	D	20	20	20	20	20	20
	Date:	12/5/11	12/6/11	12/7/11	12/8/11	12/9/11	12/10/11
	Time:	1700	0830	0930	0900	1155	1155
	Initials:	[illegible]	TK	An	[illegible]	R	KR

* one plant sacrificed for weight & length measurement

① 7/23/12, E

② 7/23/12, Ct – see previous page for control biological data

FCETL QA Form No. 069
Revision 1
Effective 06/93

SEED GERMINATION BIOLOGICAL DATA

ak 7/23/12
GLM 07/23/12

Project Number: 60147216-445- (035-038)	
Test Species (Circle): *Lactuca sativa* Other (Specify): ***E. crusgalli***	

Conc.	Test Replicate	Number of Surviving Seedlings Day 72	Number of Surviving Seedlings Day 73	Number of Surviving Seedlings Day 74	Number of Surviving Seedlings Day 75	Number of Surviving Seedlings Day 76	Number of Surviving Seedlings Day 77
0	A	20	20	20	20	20	20
	B	20	20	20	20	20	20
	C	20	20	20	20	20	20
	D	20	20	20	20	20	20
	Date:	12/11/11	12/12/11	12/13/11	12/14/11	12/15/11	12/16/11
	Time:	0930	0930	0930	0900	1600	0900
	Initials:	KB	TK	KB	ak for BP	ak for BP	TK

SEED GERMINATION BIOLOGICAL DATA

~~[illegible]~~ 7/26/12
QA: AR 01/24/12

Project Number: 60147216-445- (035-038)

Test Species (Circle): *Lactuca sativa* Other (Specify): ***E. crusgalli***

Conc.	Test Replicate	Number of Surviving Seedlings Day 72	Number of Surviving Seedlings Day 73	Number of Surviving Seedlings Day 74	Number of Surviving Seedlings Day 75	Number of Surviving Seedlings Day 76	Number of Surviving Seedlings Day 77
0	A	~~20~~	~~20~~	~~20~~	~~20~~	~~20~~	~~20~~
	B	~~20~~	~~20~~	~~20~~ ③	~~20~~	~~20~~	~~20~~
	C	~~20~~	~~20~~	~~20~~	~~20~~	~~20~~	~~20~~
	D	~~20~~	~~20~~	~~20~~	~~20~~	~~20~~	~~20~~
APG-06-MA-060311	A	19	19	19	19	19	19
	B	20	20	20	20	20	20
	C	20	20	20	20	20	20
	D	20	20	20	20	20	20
APG-15-MA-060311	A	19	19	19	19	19	~~19~~ ① 18
	B	20	20	20	20	20	20
	C	20	20	20	20	20	20
	D	20	20	20	20	20	~~20~~ ① 24
APG-02-MA-060311	A	19	19	19	19	19	19
	B	20	20	20	20	20	20
	C	20	20	20	20	20	20
	D	20	20	20	20	20	20
APG-16-MA-060311	A	19	19	19	19	19	19
	B	20	20	20	20	20	20
	C	20	20	20	20	20	20
	D	20	20	20	20	20	20
	Date:	12/11/11	12/12/11	12/13/11	12/14/11	12/15/11	12/16/11
	Time:	0930	0930	0930	0900	1600	0900
	Initials:	KB	TR	KB	[illegible] for BP	BP	P

① DM 1/13/12 E ② [illegible] 7/23/12, E
③ [illegible] 7/23/12, Cf - see previous page for control biological data.

FCETL QA Form No. 069
Revision 1
Effective 06/93

SEED GERMINATION BIOLOGICAL DATA

&7/20/12
Gwm 07/23/12

Project Number: 60147216-445-(035-038)	
Test Species (Circle): *Lactuca sativa*	Other (Specify): ***E. crusgalli***

Conc.	Test Replicate	Number of Surviving Seedlings Day 78	Number of Surviving Seedlings Day 79	Number of Surviving Seedlings Day 80	Number of Surviving Seedlings Day 81	Number of Surviving Seedlings Day 82	Number of Surviving Seedlings Day 83	Number of Surviving Seedlings Day 84
0	A	19	19	19	19	19	① ~~20~~ 19	19
	B	19	19	19	19	19	① ~~20~~ 19	19
	C	20	20	20	① ~~19~~ 20	20	20	20
	D	20	20	20	① ~~19~~ 20	20	20	~~19~~ 20
APG-06-MA-060311	A							③
	B							
	C							
	D							
APG-15-MA-060311	A							
	B							
	C							
	D							
APG-02-MA-060311	A							
	B							
	C							
	D							
APG-16-MA-060311	A							
	B							
	C							
	D							
	Date:	12/17/11	12/18/11	12/19/11	12/20/11	12/21/11	12/22/11	12/23/11
	Time:	0900	0930	1338	1530	0850	0835	0900
	Initials:	TK	TK	DM	BP	AS	TE	DM

① & 2/20/12 E
② & 7/23/12, E

③ Gwm for DM 07/23/12 C: 20 plants survived at test term.

SEED GERMINATION BIOLOGICAL DATA

de 7/20/12
GMM 07/23/12

Project Number: 60147216-445- (035-038)

Test Species (Circle): *Lactuca sativa* Other (Specify): ***E. crusgalli***

Conc.	Test Replicate	Number of Surviving Seedlings Day 85	Number of Surviving Seedlings Day 86	Number of Surviving Seedlings Day 87	Number of Surviving Seedlings Day 88	Number of Surviving Seedlings Day 89	Number of Surviving Seedlings Day 90	Number of Surviving Seedlings Day 91
0	A	19	19	19	19	19	19	19
	B	19	19	19	19	19	19	19
	C	20	20	20	20	20	20	20
	D	③ ~~19~~ 20	③ ~~19~~ 20	③ ~~19~~ 20	③ ~~19~~ 20	③ ~~19~~ 20	③ ~~19~~ 20	① ~~19~~ 20
APG-06-MA-060311	A							
	B							
	C							
	D							
APG-15-MA-060311	A							
	B							
	C							
	D							
APG-02-MA-060311	A							
	B							
	C							
	D							
APG-16-MA-060311	A							
	B							
	C							
	D							
	Date:	12/24/11	12/25/11	12/26/11	12/27/11	12/28/11	12/29/11	12/30/11
	Time:	1200	1445	0830	0940	0930	0845	1345
	Initials:	AJ	AB	AJ	AB	TK	TK	TK

① DM 1/13/12 E ② de 7/23/12, E ③ GMM for AB & TK 07/23/12 E: 20 plants alive at test termination

FCETL QA Form No 089
Revision 0
Effective 3/95

CHEMICAL DATA - Up to 14-Day Test

7/20/12

Project Number: 60147216-445-(0250038)	Test Species (Circle): D. magna H. azteca C. tentans E. foetida L. variegatus Other (Specify): *E. crusgalli* 7/23/12

Conc.	Rep.	Temperature (°C) 0 New	1 Old	2 Old	3 Old	4 Old	5 Old	6 Old	7 Old	8 Old	9 Old	10 Old	11 Old	12 Old	13 Old	14 Old
0	A	21				22				20				22		
	B		22				23				19				21	
	C			23				21				21				20
	D			~~20~~ ①	23				20				21			
APG-06-MA-060311	A	21				23				20				22		
	B		22				23				20				21	
	C			23				22				21				21
	D				22				19			~~21~~ ①	21			
APG-15-MA-060311	A	21				23				20				22		
	B		21				22				19				21	
	C			23				22				21				21
	D				21				19				21			
APG-02-MA-060311	A	21				21				20				22		
	B		22				24				20				21	
	C			23				21				22				21
	D				22				20				22			
APG-16-MA-060311	A	21				23				21				22		
	B		22				23				19				21	
	C			23				21				21				NR
	D				21				19			~~21~~ ②	20			
	A															
	B															
	C															
	D															
Meter#		D41	D41	D41	D41	D41	D41	D41	D41	D41	D41	D41	D41	D41	D41	D41
Date:		9/30/11	10/1/11	10/2/11	10/3/11	10/4/11	10/5/11	10/6/11	10/7/11	10/8/11	10/9/11	10/10/11	10/11/11	10/12/11	10/13/11	10/14/11
Time:		1635	0940	1000	1500	0900	0840	0900	0830	0945	1000	1730	1515	0835	1640	1000
Initials:		[illegible]	Am	Am	Am	[illegible]	AP	[illegible]	[illegible]	KB	KB	[illegible]	[illegible]	KB	[illegible]	TF

① Am 10/8/11 WP ③ 7/23/12 LE ② 10/11/11 E

FCETL QA Form No 089
Revision 0
Effective 3/95

CHEMICAL DATA - Up to 14-Day Test

AK 7/20/12

Project Number: 60147216-445- (035-038)	Test Species (Circle): D. magna H. azteca C. tentans E. foetida L. variegatus Other (Specify): **E. crusgalli** (mm 07/23/12)

Conc.	Rep.	Temperature (°C) 15	16	17	18	19	20	21	22	23	24	25	26	27	28	29
		Old	Old	Old	Old	Old	Old	Old	Old	Old	Old	Old	Old	Old	Old	Old
0	A		22				19				16				17	
	B			20				17				18				16
	C				16				18				13			
	D	21				16				18				17		
APG-06-MA-060311	A		22				18				16				17	
	B		① ~~22~~	20				19				19	③ ~~14~~			16
	C				17				18				14			
	D	22				17				18				15		
APG-15-MA-060311	A		22				18				17				17	
	B		④	20				19				18				15
	C				17				18				13			
	D	22				17				18				16		
APG-02-MA-060311	A		22				19				16				16	
	B			20				19				19				16
	C				17				19				14			
	D	21				16				19				16		
APG-16-MA-060311	A		22				18				17				17	
	B			20				19				18				16
	C				17				18				14			
	D	22				17				17				15		
	A															
	B															
	C															
	D															
Meter#		D41	D41	D41	D41	D41	D41	D41	D41	D41	D41	D41	D41	D41	D41	D41
Date:		10/15/11	10/16/11	10/17/11	10/18/11	10/19/11 ②	10/20/11	10/21/11	10/22/11	10/23/11	10/24/11	10/25/11	10/26/11	10/27/11	10/28/11	10/29/11
Time:		1600	0900	1545	0900	0840	1600	1010	1540	1520	1130	1425	1530	1600	1100	0935
Initials:		BP	AB	TK	AB	KB	TK	[illegible]	TK	TK	AB	DM	[illegible]	TK	DM	KB

① AB 10/16/11 wp ② KB 10/19/11 E ③ [illegible] 10/26/11 WP ④ AK 7/23/12, E

CHEMICAL DATA - Up to 14-Day Test

dk 7/20/12

Project Number: 60147216-445- (035-038)	Test Species (Circle): D. magna H. azteca C. tentans E. foetida L. variegatus Other (Specify): **E. crusgalli** (km 07/13/12)

Conc.	Rep.	30 Old	31 Old	32 Old	33 Old	34 Old	35 Old	36 Old	37 Old	38 Old	39 Old	40 Old	41 Old	42 Old	43 Old	44 Old
		Temperature (°C)														
0	A			17				19				18				19
	B				20				20				19			
	C	16				20				17				18		
	D		17				21				21				20	
APG-06-MA-060311	A			17				19				18				19
	B				20				19				19			
	C	16				19				19				19		
	D		17				20				19				19	
APG-15-MA-060311	A			18				19				20				19
	B				19				19				19			
	C	16				19				18				18		
	D		18				19				20				19	
APG-02-MA-060311	A			17				20				18				19
	B				20				19							
	C	16				19				19			20	18		
	D		18				20				19				19	
APG-16-MA-060311	A			17				19				19				20
	B				19				19				19			
	C	16				19				18				18		
	D		17				19				19				19	
	A															
	B															
	C															
	D															
Meter#		D41	D41	D41	D41	D41	D41	D41	D41	D41	D41	D41	D41	D41	D41	D41
Date:		10/30/11	10/31/11	11/1/11	11/2/11	11/3/11	11/4/11	11/5/11	11/6/11	11/7/11	11/8/11	11/9/11	11/10/11	11/11/11	11/12/11	11/13/11
Time:		1045	0845	0850	0910	1000	1130	0940	1030	1125	0945	1535	0900	0910	1000	1000
Initials:		KB	BP	AM	[illegible]	KB	[illegible]	BP	BP	[illegible]	BP	TK	BP	KB	Am	Am

① dk 7/23/12, E

7/20/12
07/23/12

CHEMICAL DATA - Up to 14-Day Test

Project Number: 60147216-445-(035-038)

Test Species (Circle): *D. magna* *H. azteca* *C. tentans* *E. foetida* *L. variegatus* Other (Specify): ***E. crusgalli***

Conc.	Rep.	Temperature (°C) 45 Old	46 Old	47 Old	48 Old	49 Old	50 Old	51 Old	52 Old	53 Old	54 Old	55 Old	56 Old	57 Old	58 Old	59 Old
0	A				19				19				21			
	B	19				20				21				20		
	C		17				20				20				17	
	D			19				19				20				18
APG-06-MA-060311	A				19				19				20			
	B	18				20				20				20		
	C		17				21				20				18	
	D			19				19				20				19
APG-15-MA-060311	A				20				19				20			
	B	17				22				21				20		
	C		18				21				20				18	
	D			19				19				21				20
APG-02-MA-060311	A				19				20				21			
	B	19				21				20				20		
	C		18				21				21				18	
	D			19				19				21				20
APG-16-MA-060311	A				19				19							
	B	18				20				21				20		
	C		17				20				21				18	
	D			19				19				21				19
	A															
	B															
	C															
	D															
Meter#		D41	D41	D41	D41	D41	D41	D41	D41	D41	D41	D41	D41	D41	D41	D41
Date:		11/14/11	11/15/11	11/16/11	11/17/11	11/18/11	11/19/11	11/20/11	11/21/11	11/22/11	11/23/11	11/24/11	11/25/11	11/26/11	11/27/11	11/28/11
Time:		1630	1430	0830	0845	0900	1345	0900	0830	0900	1000	1000	1430	0930	0930	0930
Initials:		[illegible]	TK	BP	TK	BP	TK	TO	TO	AM	KB	BP	BP	TK	TK	KB

① 07/23/12, E

FCETL QA Form No 089
Revision 0
Effective 3/95

CHEMICAL DATA - Up to 14-Day Test

AK 2/20/12

Project Number: 60147216-445- (035-038)

Test Species (Circle): *D. magna* *H. azteca* *C. tentans* *E. foetida* *L. variegatus* Other (Specify): ***E. crusgalli*** GM 07/23/12

Conc.	Rep.	Temperature (°C) 60	61	62	63	64	65	66	67	68	69	70	71	72	73	74
		Old	Old	Old	Old	Old	Old	Old	Old	Old	Old	Old	Old	Old	Old	Old
0	A	19				18				17				16		
	B		18				17				17				16	
	C			18				16				16				16
	D				18				16				17			
APG-06-MA-060311	A	19				19				18				14		
	B		18				18				17				15	
	C			19				16				14				15
	D				17				16				15			
APG-15-MA-060311	A	19				18				~~15~~ 16				14		
	B		17				18				16				15	
	C			19				18				15				16
	D				16				15				16			
APG-02-MA-060311	A	19				19				15				14		
	B		18				17				17				16	
	C			19				17				16				16
	D				17				16				16			
APG-16-MA-060311	A	19				18				17				14		
	B		18				17				15				15	
	C			19				17				16				16
	D				16				16				16			
	A															
	B															
	C															
	D															
Meter#		D41	D41	D41	D41	D41	D41	D41	D41	D41	D41	D41	D41	D41	D41	D41
Date:		11/29/11	11/30/11	12/1/11	12/2/11	12/3/11	12/4/11	12/5/11	12/6/11	12/7/11	12/8/11	12/9/11	12/10/11	12/11/11	12/12/11	12/13/11
Time:		0900	0915	0940	0900	1130	1050	1105	0830	0900	0800	1155	1155	0935	0930	0930
Initials:		BP	BP	BP	[illegible]	AM	AM	TK	TK	AM	AB	TK	KB	KB	TK	KB

① AM 12/7/11 WP ② AK 7/23/12, E

FCETL QA Form No 089
Revision 0
Effective 3/95

CHEMICAL DATA - Up to 14-Day Test

7/20/12

Project Number: 60147216-445-(035-038)

Test Species (Circle): *D. magna* *H. azteca* *C. tentans* *E. foetida* *L. variegatus* Other (Specify): ***E. crusgalli*** 07/23/12

Conc.	Rep.	Temperature (°C) 75	76	77	78	79	80	81	82	83	84	85	86	87	88	89
		Old	Old	Old	Old	Old	Old	Old	Old	Old	Old	Old	Old	Old	Old	Old
0	A		18				17				19				17	
	B			17				18				19				18
	C				17				17				19			
	D	18				17				19				19		
APG-06-MA-060311	A		16													
	B			17												
	C															
	D	17														
APG-15-MA-060311	A		16													
	B			17												
	C															
	D	16														
APG-02-MA-060311	A		17													
	B			17												
	C															
	D	17														
APG-16-MA-060311	A		17													
	B			16												
	C															
	D	16														
	A															
	B															
	C															
	D															
Meter#		D41	D41	D41	D41	D41	D41	D41	D41	D41	D41	D41	D41	D41	D41	D41
Date:		12/14/11	12/15/11	12/16/11	12/17/11	12/18/11	12/19/11	12/20/11	12/21/11	12/22/11	12/23/11	12/24/11	12/25/11	12/26/11	12/27/11	12/28/11
Time:		1600	1600	0855	0900	0830	1338	1530	0835	0835	0905	1200	1445	0820	0915	0930
Initials:		mt	BP	TK	TK	R	DM	BP	AG	TK	DM	AG	[illegible]	AJ	AB	TK

① 07/23/12, E

FCETL QA Form No 089
Revision 0
Effective 3/95

CHEMICAL DATA - Up to 14-Day Test

[initials] 7/20/12

Project Number: 60147216-445-(035-038)	Test Species (Circle): D. magna H. azteca C. tentans E. foetida L. variegatus Other (Specify): **E. crusgalli** GVM 07/23/12

Conc.	Rep.	Temperature (°C) 90 Old	91 Old	92 Old	93 Old	94 Old	95 Old	96 Old	97 Old	98 Old	99 Old	100 Old	101 Old	102 Old	103 Old	104 Old
0	A		22													
	B		22													
	C	19	21													
	D		21													
APG-06-MA-060311	A															
	B															
	C															
	D															
APG-15-MA-060311	A															
	B															
	C															
	D															
APG-02-MA-060311	A															
	B															
	C															
	D															
APG-16-MA-060311	A															
	B															
	C															
	D															
	A															
	B															
	C															
	D															
Meter#		D41	D41													
Date:		12/29/11	12/30/11													
Time:		0845	1345													
Initials:		TB	TE													

①[initials] 7/23/12, E

DAILY TOXICITY TEST LOG

7/20/12
GLM 07/23/12

Project Number: 60147216-445- (035-038)	
Test Species (Circle): C. dubia D. magna D. pulex P. promelas O. mykiss	Other (Specify): ***E. crusgalli***

General Comments		Hydration: 20 ml ~~Hoaglands Solution~~ ②	Initials/Date
Test Day 0	Test Solution Mixed at: 1330-1600 Light Intensity = 388 ft-c Test Organisms Added at: 1330-1600 humidity = 53% (meter D71)	20 ml ~~Hoagland's~~ ② @1330-1600 MQ	Am 9/30/11
Air Test Day 1	Temp 22.3 °C (avg) min/max ~~22.6~~ ① 20.8-22.6 °C Humidity = 59% (Meter #D71)	None/MQ	Am 10/1/11
Air Test Day 2	Temp. 23.2 °C (x̄) min/max 21.6-23.6 °C Humidity = 56% (meter #D71)	None/MQ	Am 10/2/11
Air Test Day 3	Temp 22.8 °C (x̄) min/max 22.0-24.1 °C Humidity = 50% (Meter #D71)	20 ml ~~Hoagland's~~ ② @ 1650	Am 10/3/11
Air Test Day 4	Temp 23.3 °C (x̄) min/max: 22.5-24.3 °C Humidity = 50% (meter #D71)	None/MQ	10/4/11
Air Test Day 5	Temp: 23.3 °C (x̄) min/max 22.7-24.2 °C Humidity: 53% (meter #D71)	None/MQ	AP 10/5/11
Air Test Day 6	Temp: 21.9 °C (x̄) min/max: 23.8-21.9 °C Humidity: 48% (meter #D71)	None/MQ	10/6/11
Air Test Day 7	Temp: 19.6 °C (x̄) min/max: 18.5-20.6 °C Humidity: 42% (meter # D71)	20 ml ~~Hoagland's~~ ① @ 1615	10/7/11
Air Test Day 8	Temp = 20.3 °C (x̄) min/max: 19.3-20.5 °C Humidity: 47% (meter #D71)	none/MQ	KB 10/8/11

① Am 10/1/11 WP
② 7/23/12; cf: modified Forsuch nutrient solution
③ 7/23/12, E

DAILY TOXICITY TEST LOG

★ 7/20/12
GRM 07/23/12

Project Number: 60147216-445- (035-038)

Test Species (Circle): *C. dubia* *D. magna* *D. pulex* *P. promelas* *O. mykiss* Other (Specify): ***E. crusgalli***

General Comments		Hydration: 20 ml ~~Hoagland's~~ ② ~~Solution~~	Initials/Date
Test Day 9	Air Temp (x̄) = 19.6°C 19.5°C - 20.3°C Humidity : 50% (meter D71)	none/MQ	KB 10/9/11
Test Day 10	Air Temp. (x̄) = 22.0°C 21.8 - 22.1°C Humidity = 56% (meter D71)	None/MQ	★ 10/10/11
Test Day 11	Air Temp (x̄) = 22.6°C 21.8 - 23.4°C Humidity = 54% (meter D71)	20 ml ~~Hoagland's~~ ② @ 1500 /MQ	★ 10/11/11
Test Day 12	Air Temp (x̄) = 22.7°C 22.2 - 23.4°C Humidity = 40% (meter D71)	none/MQ	KB 10/12/11
Test Day 13	Air Temp (x̄) = 22.6°C 23.3 - 21.3°C Humidity = 52% (meter D71)	None/MQ	★ 10/13/11
Test Day 14	Air Temp (x̄) = 22.4°C 22.4 - 24.6°C Humidity 50% ★ start 2nd set of controls (meter #D71)	20 ml ~~Hoagland's~~ ③ @ 1005 / MQ	R 10/14/11
Test Day 15	Air Temp (x̄): 22.9°C 22.3 - 24.6°C Humidity 57% (meter D71)	None/MQ	BP 10/15/11
Test Day 16	Air Temp (x̄) - 24.1°C 23.3 - 25.0°C Humidity 50% (meter D71)	None/MQ	AB 10/16/11
Test Day 17	Air Temp (x̄) = 23.3°C 23.2 - 24.8°C Humidity 50% (meter D71)	DI/MQ	R 10/~~16~~ 17/11 ①

① AR for TK 07/10/12 E

② ★ 7/23/12; CF: modified Gorsuch nutrient solution

③ ★ 7/23/12, E

DAILY TOXICITY TEST LOG

AR 7/20/12

Project Number: 60147216-445- (035-038)	GRM 07/23/12
Test Species (Circle): C. dubia D. magna D. pulex P. promelas O. mykiss Other (Specify): **E. crusgalli**	

General Comments		Hydration: 20 ml ~~Hoagland's Solution~~ ④	Initials/Date
Test Day 18 Air	~~Ct~~ ① Temp (x̄): 20.0°C 20.0°C - 21.3°C Humidity: 44% (meter D71)	20 ml ~~Hoagland's~~ ④ @0900/DI	AB 10/18/11
Test Day 19 Air	Temp: 19.2°C (x̄) 19.2 - 21.2°C Humidity: 39% (meter D71)	none/DI	KB 10/19/11
Test Day 20 Air	Temp: 22.4°C (x̄) 20.6 - 22.4°C Humidity: 41% (meter D71)	None/DI	K 10/20/11
Test Day 21 Air	Temp. ~~22~~ 21.6°C ② (x̄) 22.9 - 21.6°C Humidity: 44% (meter D71)	20 ml ~~Hoagland's~~ ④ @ 1000	AR 10/~~24~~ 21/11 ③
Test Day 22 Air	Temp: 23.2°C (x̄) 21.8 - 23.5°C Humidity 40% (meter D71)	None/MQ	R 10/22/11
Test Day 23 Air	Temp: 23.5°C (x̄) 21.7 - 23.5°C Humidity: 40% (meter D71)	none/MQ	K 10/23/11
Test Day 24 Air	Temp: 22.3°C (x̄) 22.1 - 24.6°C Humidity: 43% (meter D71)	None/MQ	AB 10/24/11
Test Day 25 Air	Temp: 22.~~8~~°C (x̄) 22.7 - 24.9 Humidity - 44% (meter D71)	20 ml ~~Hoagland's~~ ④ @ 1640/DI	DM 10/25/11
Test Day 26 Air	Temp: 17.9°C (x̄) 17.7 - 22.1°C Humidity: NR (meter D71)	None/DI	AR 10/26/11

① AB 10/18/11 E ② AR 10/21/11 E ③ AR for AMP 07/10/12 E
NR = Not Recorded
④ AR 7/23/12; cf: modified Gorsuch nutrient solution
⑤ AR 7/23/12, E

FCETL QA Form No. 055
Revision 2
Effective 1/94

DAILY TOXICITY TEST LOG

de 7/20/12
GMM 07/23/12

Project Number: 60147216-445-(035-038)	
Test Species (Circle): C. dubia D. magna D. pulex P. promelas O. mykiss Other (Specify): ***E. crusgalli***	

General Comments		Hydration: 20 ml ~~Hoagland's solution~~ (4)	Initials/Date
Test Day 27 Air	Temp: 19.8°C (x̄) 17.8 – 19.8°C Humidity: 42% (meter D71)	none / DI	TK 10/27/11
Test Day 28 Air (meter D71)	Temp: 19.3°C (x̄) 18.9 – 20.3°C (360, 378, 384, 365, 370) Humidity 48% Light Intensity ~371 ft.-c	20 ml ~~Hoagland's~~ (4) @0915 / DI	KB 10/28/11
Test Day 29 Air	Temp: 19.~~8~~ 3°C (x̄) (1) ~~18.9~~ 19.1 – 20.~~8~~ 1 °C Humidity ~~52~~ 42% (Meter D71)	none / DI	~~DM~~ (1) KB 10/~~28~~ 29/11
Test Day 30 Air	Temp: 20.0°C (x̄) 19.9 – 20.9°C Humidity 47% (meter D71)	none / DI	KB 10/30/11
Test Day 31 Air	Temp: ~~20.8°C~~ (3) (x̄) ~~20.8 – 21.6°C~~ (3) Humidity ~~46%~~ (2) (meter D71)	~~None / DI~~ (3) None / DI	~~AB~~ (3) 10/31/11
Test Day 32 Air	Temp: 20.8°C (x̄) 20.8 – 21.6°C Humidity 46% (meter D71)	20 ml ~~Hoagland's~~ (4) @0850 / DI ~~AAG~~ (1)	AB 11/1/11
Test Day 33 Air	Temp 21.6°C (x̄) 20.8 – 21.9°C Humidity = 46% (meter D71)	DI AM /	11/2/11
Test Day 34 Air	Temp: 21.6°C (x̄) 21.5 – 22.2°C Humidity = 42% (meter D71)	none / DI	KB 11/3/11
Test Day 35 Air (meter D71)	Temp - 21.7°C (x̄) 21.5 – 22.0°C (385, 362, 350, 373, 354) Humidity = 44% Light intensity ~365 ft.c	DI & ~~Hoglands~~ (4) (AM)	11/4/11

(1) KB 10/29/11 E

(2) AB 11/1/11 WP

(3) de 07/23/12, E

(4) de 07/23/12, cf - modified Gorsuch's solution

~~Page of~~ ③

FCETL QA Form No. 055
Revision 2
Effective 1/94

DAILY TOXICITY TEST LOG

de 7/20/12
hm 07/23/12

Project Number: 60147216-445- (035-039)	
Test Species (Circle): C. dubia D. magna D. pulex P. promelas O. mykiss Other (Specify): ***E. crusgalli***	

General Comments		Hydration: 20 ml ~~Hoagland's~~ ④ solution	Initials/Date
Test Day 36 Air	Temp: 21.5°C 21.4 - 22.1°C ($\bar{x}$) Humidity: 46% (meter D71)	DI AM	BP 11/5/11
Air Test Day 37	Temp: 23.0°C 22.8 - 24.6°C ($\bar{x}$) Humidity: 42% (meter D71)	20 ml ~~Hoagland's~~ ④ @ 1030	BP 11/6/11
Air Test Day 38	Temp: 21.8°C 21.6 - 23.8°C ($\bar{x}$) Humidity: 40% (meter D71)	none/ DI	mtX ② 11/7/11
Air Test Day 39	Temp: 21.3°C 21.1 - 22.1°C ($\bar{x}$) Humidity: 39% (meter D71)	DI/none	BP 11/8/11
Air Test Day 40	Temp: 21.6°C 21.6 - 21.6°C ($\bar{x}$) Humidity: 38% (meter D71)	None/ DI	K 11/9/11
Air Test Day 41	Temp: 20.9°C 20.7 - 21.6°C ($\bar{x}$) Humidity: 39% (meter D71)	20 ml ~~Hoagland's~~ ④ @ 0900	BP 11/10/11
Air Test Day 42 (meter D71)	Temp: 20.6°C 20.5 - 21.4°C ($\bar{x}$) Humidity: 35% Light Intensity:	none/ DI	KB 11/11/11
Air Test Day 43	Temp: 20.9°C 20.6 - 21.3°C ($\bar{x}$) Humidity: 44% (meter D71)	None/DI	Am 11/12/11
Air Test Day 44	Temp: 20.9°C 20.3 - 21.4°C ($\bar{x}$) Humidity: 43% (meter D71)	None/DI	Am 11/13/11

③ de 7/23/12, E

④ de 7/23/12, cf - modified Gorsuch nutrient solution

At 0900 on 11-~~07~~ ① 06-11, the lab clocks were set back one hour to 0800 to adjust time to Mountain Standard Time. All times recorded for data on this day are Mountain Standard times. Initials: BP.

① BP 11/6/11 E

FCETL QA Form No. 055
Revision 2
Effective 1/94

DAILY TOXICITY TEST LOG

7/20/12
mm 07/23/12

Project Number: 60147216-445-(035-038)

Test Species (Circle): C. dubia D. magna D. pulex P. promelas O. mykiss Other (Specify): ***E. crusgalli***

General Comments		Hydration: ① 20 ml ~~Hoagland's~~ solution	Initials/Date
Air Test Day 45 (meter D71)	Temp: 19.3 °C (x̄) 19.3-21.1°C Humidity: 38% Light Intensity ~310ft	none/DI	mt 11/14/11
Air Test Day 46 (meter D71)	Temp: 20.3 °C (x̄) 20.2 - 20.3 °C Humidity: 42% 2bulbs changed out & foil reflective shield added.	① 20 ml ~~Hoagland's~~ @ 1430 light intensity 401ft-c	K 11/15/11
Air Test Day 47	Temp: 21.6°C (x̄) 20.2 - 22.1°C Humidity: 34% (meter D71)	DI	BP 11/16/11
Air Test Day 48	Temp: 22.0 °C (x̄) 21.7 - 22.3 °C Humidity: 30% (meter D71)	none/DI	K 11/17/11
Air Test Day 49	Temp: 21.8°C 21.7-22.6°C (x̄) Humidity: 34% (meter D71)	DI/none	BP 11/18/11
Air Test Day 50	Temp: 23.2 °C (x̄) 23.1 - 23.2 °C Humidity: 41% (meter D71)	① 20 ml ~~Hoagland's~~ @ 1345	K 11/19/11
Air Test Day 51	Temp: 22.2 °C (x̄) 21.9 - 22.3 °C Humidity: 37% (meter D71)	none/DI	K 11/20/11
Air Test Day 52 (meter D71)	Temp: 22.1 °C (x̄) 21.9 - 22.8 °C Humidity: 43% Light intensity ~380 ft-c	① ~~Hoagland's @ 1309~~ mt none/DI	K 11/21/11
Air Test Day 53	Temp: 22.8°C (x̄) 21.3 - 22.8°C Humidity: 38% (meter D71)	None/DI	AM 11/22/11

① 7/23/12, Cf-modified Gorsuch nutrient solution
② 7/23/12, E

DAILY TOXICITY TEST LOG

~~①~~ 7/20/12
GRM 07/23/12

Project Number: 60147216-445-(035-038)

Test Species (Circle): C. dubia D. magna D. pulex P. promelas O. mykiss Other (Specify): **E. crusgalli**

General Comments		Hydration: ③ 20 ml ~~Hoagland's~~ solution	Initials/Date
Test Day 54 Air	Temp - 21.0°C ($\bar{x}$) 21.0 - 21.1°C Humidity - 34% (meter D71)	none/DI	KB 11/23/11
Test Day 55 Air	Temp: 21.2°C ($\bar{x}$) 20.9 - 21.7°C Humidity: 32% ① ~~Light~~ (meter D71)	20 ml ~~Hoagland's~~ ③ @ 1000	BP 11/24/11
Test Day 56 Air (meter D71)	Temp: 22.5°C ($\bar{x}$) 21.2 - 22.7°C Humidity: 32% Light intensity: 382 ft-C	None/DI	BP 11/25/11
Test Day 57 Air	Temp: 21.7°C ($\bar{x}$) 21.6 - 22.7°C Humidity: 24% (meter D71)	20 ml ~~Hoagland's~~ ③ @ 1330	TF 11/26/11
Test Day 58 Air	Temp: 20.1°C ($\bar{x}$) 19.8 - 21.5°C Humidity: 30% (meter D71)	none/DI	TF 11/27/11
Test Day 59 Air	Temp: 20.3°C ($\bar{x}$) 20.1 - 20.7°C Humidity = 27% (meter D71)	none/DI	KB 11/28/11
Test Day 60 Air	Temp: 19.9°C ($\bar{x}$) 19.9 - 20.8°C Humidity: 33% (meter D71)	20 ml ~~Hoagland's~~ ③ @ 0900	BP 11/29/11
Test Day 61 Air	Temp: 20.5°C ($\bar{x}$) 20.3 - 21.0°C Humidity: 39% (meter D71)	None/DI	BP 11/30/11
Test Day 62 Air	Temp: 20.9°C ($\bar{x}$) 20.7 - 21.5°C Humidity: 40% (meter D71)	20 ml ~~Hoagland's~~ ③ @ 1520	BP 12/1/11

①BP 11/25/11 WP
② 7/23/12, E
③ 7/23/12, Cf - modified Forsuch nutrient solution

DAILY TOXICITY TEST LOG

~~d 7/20/12~~
~~Gum~~ 07/23/12

Project Number: 60147216-445- (035-038)

Test Species (Circle): C. dubia D. magna D. pulex P. promelas O. mykiss Other (Specify): ***E. crusgalli***

General Comments		Hydration: ④ 20 ml ~~Hoagland's~~ solution	Initials/Date
Air Test Day 63 (meter D71)	Temp. 18.9°C (x̄) 18.4 - 19.0°C Humidity = 33% Light intensity =	AM: DI PM: DI 381 ft-c	12/2/11
Air Test Day 64	Temp. 20.5°C (x̄) 18.9-20.9°C Humidity = 32% (meter D71)	20 ml ~~Hoagland's~~ ④ @ 1145 am: DI pm: DI	12/3/11
Air Test Day 65	Temp. 17.8°C (x̄) 16.8-19.8°C Humidity = 32% (meter D71)	DI only	12/4/11
Air Test Day 66	Temp: 19.6 °C (x̄) 18.1- 19.6 °C Humidity: 30% (meter D71)	20 ml ~~Hoagland's~~ ④ @ ① ~~1110~~ 1625 / DI	12/5/11
Air Test Day 67	Temp: 20.0 °C (x̄) 19.5- 21.1 °C Humidity: 30% (meter D71)	DI	12/6/11
Air Test Day 68	~~Tep~~ ② Temp: 19.8°C (x̄) 18.2 - 19.9°C Humidity: 30% (meter D71)	DI only	12/7/11
Air Test Day 69	Temp: 16.2°C (x̄) 14.6-27.5°C Humidity: 35% (meter D71)	20 ml ~~Hoagland's~~ ④ @0850 /DI	12/8/11
Air Test Day 70 (meter D71)	Temp: 16.1 °C (x̄) 14.6-27.3°C Humidity: 35% Light intensity =	NR DI	12/9/11
Air Test Day 71	Temp - 18.8°C (x̄) 16.9 - 25.7 °C Humidity: 34% (meter D71)	20 ml ~~Hoagland's~~ ④ @ 1145 / DI	12/10/11

① 12/5/11 E
② 12/7/11 E
③ 7/23/12, E
④ 7/23/12, Cf-modified Gorsuch nutrient solution.

DAILY TOXICITY TEST LOG

dk 7/20/12

Project Number: 60147216-445- (035-038)
Test Species (Circle): C. dubia D. magna D. pulex P. promelas O. mykiss Other (Specify): ***E. crusgalli***

General Comments		Hydration: ④ 20 ml ~~Hoagland's~~ solution	Initials/Date
Test Day 72 Air	Temp ($\bar{x}$) 16.8°C 15.9 - 20.7°C Humidity : 35% (meter D71)	DI/none	KB 12/11/11
Test Day 73 Air	Temp: 18.7°C 15.9- 20.7 °C ($\bar{x}$) Humidity : 31% (meter D71)	20 ml ~~Hoagland's~~ ④ @ 0930 DI	K 12/12/11
Test Day 74 Air	Temp: 18.1°C 15.9 - 20.7°C ($\bar{x}$) Humidity : 36% (meter D71)	DI/none	KB 12/13/11
Test Day 75 Air	Temp : 19.4°C ① ~~14.1-1~~ ①~~6~~ 16.1- 20.9°C ($\bar{x}$) Humidity : 31% (meter D71)	20 ml ~~Hoagland's~~ ④ @ 1600 DI	mt 12/14/11
Test Day 76 Air	Temp: 18.5 °C 16.8 - 21.7 °C ($\bar{x}$) Humidity : 35% (meter D71)	DI/None	BP 12/15/11
Test Day ~~76~~ 77 ② Air (meter D71)	Temp: 19.9 °C 16.8 – 21.7 °C ($\bar{x}$) (394, 382, 384, 371, 390) Humidity : 30% Light Intensity = 384 ft-c	20 ml ~~Hoagland's~~ ④ @ 0900/DI	K 12/16/11
Test Day ~~79~~ 78 ② Air	Temp: 18.6°C 16.8 – 21.7 °C ($\bar{x}$) Humidity: 30% (meter D71)	DI	K 12/17/11
Test Day ~~80~~ 79 ② Air	Temp: 18.8 °C 16.8 – 21.7 °C ($\bar{x}$) Humidity 33% (meter D71)	DI	K 12/18/11
Test Day ~~81~~ 80 ② Air	Temp: 18.0°C 16.6- 21.7°C ($\bar{x}$) Humidity 35% (meter D71)	20 ml ~~Hoagland's~~ ④ @ 1340/DI	DM 12/19/11

① 12/14/11 E mt
② dk 3/5/12 E
③ dk 7/23/12, E
④ dk 7/23/12, cf- modified Gorsuch nutrient solution

DAILY TOXICITY TEST LOG

~~1~~ 7/20/12

Project Number: 60147216-445- (035-038)

Test Species (Circle): C. dubia D. magna D. pulex P. promelas O. mykiss Other (Specify): **E. crusgalli**

General Comments		Hydration: 20 ml ~~Hoagland's~~ (3) solution	Initials/Date
Test Day ~~78~~ 821 (1)	Air Temp: 18.6°C ($\bar{x}$) 16.8 - 21.7°C Humidity: 30% (meter D71)	None/DI	BP 12/20/11
Test Day ~~79~~ 832 (1)	Temp: NR Humidity: NR	20 ml ~~Hoagland's~~ (3) @ 0835	AG 12/21/11
Test Day ~~74~~ 843 (1)	Temp: 19.7°C ($\bar{x}$) 16.4 - 21.7°C Humidity: 27% (meter D71)	DI	K 12/22/11
Test Day ~~75~~ 854 (1)	Air Temp: 22.5°C ($\bar{x}$) 20.4 - 24.2°C Humidity: 24% (meter D71)	20 ml ~~Hoagland's~~ (3) @ 0915	DM 12/23/11
Test Day ~~76~~ 865 (1)	Air Temp: 23.8°C ($\bar{x}$) 22.5 - 23.5°C Humidity 21% (meter D71)	DI	AG 12/24/11
Test Day ~~78~~ 876 (1)	Air Temp: 23.3°C ($\bar{x}$) 23.2 - 23.4°C Humidity 20% (meter D71)	20 ml ~~Hoagland's~~ (3) @ 1445	AG 12/25/11
Test Day ~~79~~ 887 (1)	Air Temp: 23.0°C ($\bar{x}$) 21.8 - 23.4 °C Humidity 23% (meter D71)	DI	AG 12/26/11
Test Day ~~80~~ 898 (1)	Air Temp: 22.4°C ($\bar{x}$) 22.2 - 24.5°C Humidity: 22% (meter D71)	DI	AG 12/27/11
Test Day ~~81~~ ~~90~~ 89 (1)	Air Temp: 19.8°C ($\bar{x}$) 16.4 - 23.2°C Humidity: 20% (meter D71)	20 ml ~~Hoagland's~~ (3) @ 0930	E 12/28/11

(1) * 3/5/12 E
(2) * 7/23/12, E
(3) * 7/23/12, CF - modified Gorsuch nutrient solution

DAILY TOXICITY TEST LOG

7/20/12
amm 07/23/12

Project Number: 60147216-445- (035-038)	
Test Species (Circle): *C. dubia* *D. magna* *D. pulex* *P. promelas* *O. mykiss* Other (Specify): ***E. crusgalli***	

General Comments		Hydration: 20 ml ~~Hoagland's~~ solution	Initials/Date
Test Day ~~82~~ 90	Air Temp: 23.5 °c ($\bar{x}$) 16.4-23.8 °c Humidity: 24% (meter D71)	DI	K 12/29/11
Test Day ~~82~~ 92 91	Air Temp: 24.6 °c ($\bar{x}$) 16.4-25.0 °c Humidity: 20% (meter D71)	~~20 ml Hoagland's~~ @ DI in AM	K 12/30/11
Test Day ~~83~~ 92			
Test Day 84		20 ml ~~Hoagland's~~ @	
Test Day 85			
Test Day 86		20 ml ~~Hoagland's~~ @	
Test Day 87			
Test Day 88			
Test Day 89		20 ml ~~Hoagland's~~ @	

① 3/5/12 E

② 7/23/12, CF - modified Gorsuch nutrient solution

445 Plant

FIVE TREATMENTS (INCLUDING CONTROL) FOUR REPLICATES
RANDOM CHAMBER LOCATION "JJ"

	1	2	3	4	5
A	5B	1C	1A	3B	5D
B	4A	5C	2D	1B	3D
C	3C	4C	4B	2B	3A
D	2C	1D	5A	4D	2A

Proj. # ~~60225~~ ①60147216-445-(035.038)

1 = control
2 = APG-06
3 = APG-15
4 = APG-02
5 = APG-16

① cwm 07/23/12 C

60147216-445-(035-038) SUBJECT: DAILY LOG GLM 07/23/11

ALL ENTRIES MUST BE INITIALLED WITH DATE AND TIME: 9/27/11 @ unk

Preparation of control formulated sediment:

Rinsed fine, medium and coarse grit silica sand with deionized until water ran through clear. Cleaned sand was placed into pyrex baking dishes, covered with aluminum foil and labeled according to grit size. Dishes were placed in a 104°C oven overnight.

Sphagnum peat moss was sieved using a 2mm sieve and rinsed with deionized water until water ran through clear. Rinsed moss was placed in a pyrex dish and covered. Baked in a 104°C oven overnight.
Note: Rinsing is thought to reduce acidity.

After baking all trays were removed from oven and allowed to cool completely.

Once cooled, ingredients were mixed together in the following quantities: 9/28/11 @ 1430

1. Fine sand: 2160g
2. Medium sand: 300g
3. Coarse sand: 90g
4. Colloidal kaolinite clay: 240g
5. Sphagnum Peat moss: 210g

Ingredients were mixed/homogenized until well blended.

Soil pH = 3.8

To adjust soil pH ~~10% (~300g)~~ ① 1% (~30g) calcium carbonate was added to mixture and homogenized.

Post calcium carbonate soil pH = 6.5

Added 30g more calcium carbonate to try to bump pH up as close to 7.0 as possible.

post 2nd $CaCO_3$ addition soil pH = 6.5

① RE for ANP 06/26/12 CF
② 7/23/12

*no more attempts to adjust pH were made. Did not want to over power sediment with $CaCO_3$ b/c ~~a~~ effect may/may have on plant nutrients.

Gam 07/23/12

60147216-445-(035-038) SUBJECT: DAILY LOG

ALL ENTRIES MUST BE INITIALLED WITH DATE AND TIME:

9/29/11 - Day (-)1

Sediment samples were individually homogenized for a minimum of 3 minutes. Once homogenization was complete each replicate sample was weighed out into a tared plastic container. Individual weights were recorded for each. After all replicates were weighed containers were ~~plas~~① placed into the environmental bath where test was to be performed.

9/30/11 - Day 0

test chambers containing sediment were removed from environmental bath and ~~MQ (20mls) and~~① (20mls) ~~Hoglands~~② Hoagland's② solution were added to each chamber and stirred in. Once stirred in, 20 holes were made in sediment and a MQ rinsed (roots) echinochloa plant/seedling was placed into a hole and sediment gently pushed against to hold in place.

Echinochloa seedlings were from lot 95-59 and were 10 days old. Batch # 092011.

Once all test chambers were planted, they were moved to the environmental bath where the test was to be conducted.

Soil pH's

APG-02 : 6.1
APG-06 : 6.7
APG-15 : 7.0
APG-16 : 6.5

9/30/11 @ 1600

① 9/29/11 E.   ② 7/23/12, CF - modified Gorsuch's.

GMM 07/23/12

60147216-445-(035-038) SUBJECT: DAILY LOG

ALL ENTRIES MUST BE INITIALLED WITH DATE AND TIME:

2nd batch w/ unwashed peat moss
Preparation of control formulated sediment: 10/14/11 @ 1620

Sieved enough peat moss to weigh out 140g. Used a 2mm sieve and did not rinse.

Weighed out: (and homogenized)

1. Fine sand: 1440g (rinsed and baked)
2. Medium sand: 200g (rinsed and baked)
3. Coarse sand: 60g (rinsed and baked.)
4. Colloidal Kaolinite clay: 160g
5. Sphagnum peat moss: 140g sieved
6. Calcium carbonate was added at rate of 1% to adjust pH.

Soil pH: 6.5 @ 1640

Formulated sediment was placed into test chambers by weighing out 500g and putting into test chamber. Sediment was moistened with MQ and 20mL Hoagland's solution and homogenized to moisten entire contents.

Seedlings from September 20, 2011 (same batch from initial initiation) were used to initiate new control sediment test chambers. 20 organisms were added to each chamber. Roots were rinsed with milli-Q and carefully placed into pre-made holes in sediment and covered with surrounding sediment.

GMM 7/23/12, E

QA: AR07/19/12

Temperature and humidity readings for definitive plant study - 60147216-445-(035-038)

Day	Temp of Treatments: Control	APG-06-MA MA-060311	APG-15-MA-060311	APG-02-MA-060311	APG-16-MA-060311	Nutrient Solution added
0		21	21	21	21	
1		22	21	22	22	
2		23	23	23	23	
3		22	21	22	21	•
4		23	23	21	23	
5		23	22	24	23	
6		22	22	21	21	
7		19	18	20	18	•
8		20	20	20	21	
9		20	19	20	19	
10		21	21	22	21	
11		21	21	22	20	•
12		22	22	22	22	
13		21	21	21	21	
14	20	21	21	21		•
15	21	22	22	21	22	
16	22	22	22	22	22	
17	20	20	20	20	20	
18	16	17	17	17	17	•
19	16	17	17	16	17	
20	19	18	18	19	18	
21	17	19	19	19	18	•
22	18	18	18	19	18	
23	18	18	18	19	17	
24	16	16	17	16	17	
25	18	19	18	19	18	•
26	13	14	13	14	14	
27	17	15	16	16	15	
28	17	17	17	16	17	•
29	16	16	15	16	16	
30	16	16	16	16	16	
31	17	17	18	18	17	
32	17	17	18	17	17	•
33	20	20	19	20	19	
34	20	19	19	19	19	
35	21	20	19	20	19	•
36	19	19	19	20	19	
37	20	19	19	19	19	•
38	17	19	18	19	18	
39	21	19	20	19	19	
40	18	18	20	18	19	
41	19	19	19	20	19	•
42	18	19	18	18	18	
43	20	19	19	19	19	
44	19	19	19	19	20	
45	18	18	17	18	18	
46	17	17	18	18	17	•
47	19	19	19	19	19	
48	19	19	20	19	19	
49	20	20	22	21	20	
50	20	21	21	21	20	•
51	19	19	19	19	19	
52	19	19	19	20	19	•
53	21	20	21	20	21	
54	20	20	20	21	21	
55	20	20	21	21	21	•
56	21	20	20	21		
57	20	20	20	20	20	•
58	17	18	18	18	18	
59	18	19	20	20	19	
60	19	19	19	19	19	•
61	18	18	17	18	18	
62	18	19	19	19	19	•
63	18	17	16	17	16	
64	18	19	18	19	18	•
65	17	18	18	17	17	
66	16	16	18	17	17	•
67	16	16	15	16	16	
68	17	18	16	15	17	
69	17	17	16	17	15	•
70	16	14	15	16	16	
71	17	15	16	16	16	•
72	16	14	14	14	14	
73	16	15	15	16	15	•
74	16	15	16	16	16	
75	18	17	16	17	16	•
76	18	16	16	17	17	
77	17	17	17	17	16	•
78	17					
79	17					
80	17					•
81	18					
82	17					•
83	19					
84	19					•
85	19					
86	19					•
87	19					
88	17					
89	18					•
90	19					
91	21 *					

	Control	APG-06-MA MA-060311	APG-15-MA-060311	APG-02-MA-060311	APG-16-MA-060311		
Min Temp:	13	14	13	14	14	count - C	28
Max Temp:	22	23	23	24	23	count - T	26
Avg. Temp:	18.18	18.68	18.65	18.86	18.53		

* Temperature taken in all replicates as 22, 22, 21, and 21.

Day	Temp of Bath: Avg	Min	Max
0			
1	22.3	20.8	22.6
2	23.2	21.6	23.6
3	22.8	22.0	24.1
4	23.3	22.5	24.3
5	23.3	22.7	24.2
6	21.9	21.9	23.8
7	19.6	18.5	20.6
8	20.3	19.3	20.5
9	19.6	19.5	20.3
10	22.0	21.8	22.1
11	22.6	21.8	23.4
12	22.7	22.2	23.4
13	22.6	21.3	23.3
14	22.4	22.4	24.6
15	22.9	22.3	24.6
16	24.1	23.3	25.0
17	23.3	23.2	24.8
18	20.0	20.0	21.3
19	19.2	19.2	21.2
20	22.4	20.6	22.4
21	21.6	21.6	22.9
22	23.2	21.8	23.5
23	23.5	21.7	23.5
24	22.3	22.1	24.6
25	22.8	22.7	24.9
26	17.9	17.7	22.1
27	19.8	17.8	19.8
28	19.3	18.9	20.3
29	19.3	19.1	20.7
30	20.0	19.9	20.9
31			
32	20.8	20.8	21.6
33	21.6	20.8	21.9
34	21.6	21.5	22.2
35	21.7	21.5	22.0
36	21.5	21.4	22.1
37	23.0	22.8	24.6
38	21.8	21.6	23.8
39	21.3	21.1	22.1
40	21.6	21.6	21.6
41	20.9	20.7	21.6
42	20.6	20.5	21.4
43	20.9	20.6	21.3
44	20.9	20.3	21.4
45	19.3	19.3	21.1
46	20.3	20.2	20.3
47	21.6	20.2	22.1
48	22.0	21.7	22.3
49	21.8	21.7	22.6
50	23.2	23.1	23.2
51	22.2	21.9	22.3
52	22.1	21.9	22.8
53	22.0	21.3	22.8
54	21.0	21.0	21.1
55	21.2	20.9	21.7
56	22.5	21.2	22.7
57	21.7	21.6	22.7
58	20.1	19.8	21.5
59	20.3	20.1	20.7
60	19.9	19.9	20.8
61	20.5	20.3	21.0
62	20.9	20.7	21.5
63	18.9	18.4	19.0
64	20.5	18.9	20.9
65	17.8	16.8	19.8
66	19.6	18.1	19.6
67	20.0	19.5	21.1
68	19.8	18.2	19.9
69	16.2	14.6	27.3
70	16.1	14.6	27.3
71	18.8	16.9	25.7
72	16.8	15.9	20.7
73	18.7	15.9	20.7
74	18.1	15.9	20.7
75	19.4	16.1	20.9
76	18.5	16.8	21.7
77	19.9	16.8	21.7
78	18.6	16.8	21.7
79	18.8	16.8	21.7
80	18.0	16.6	21.7
81	18.6	16.8	21.7
82			
83	19.7	16.4	21.7
84	22.5	20.4	24.2
85	23.8	22.5	23.5
86	23.3	23.2	23.4
87	23.0	21.8	23.4
88	22.4	22.2	24.2
89	19.8	16.4	23.2
90	23.5	16.4	23.8
91	24.6	16.4	25.0

Control	20.7960526	14.6	27.3
All Trtmnts	20.9223684	14.6	27.3

Day	Humidiy of Baths
0	53
1	59
2	56
3	50
4	50
5	53
6	48
7	42
8	47
9	50
10	56
11	54
12	40
13	52
14	50
15	57
16	50
17	50
18	44
19	39
20	41
21	44
22	40
23	40
24	43
25	44
26	
27	42
28	48
29	42
30	47
31	
32	46
33	46
34	42
35	44
36	46
37	42
38	40
39	39
40	38
41	39
42	35
43	44
44	43
45	38
46	42
47	34
48	30
49	34
50	41
51	37
52	43
53	38
54	34
55	32
56	32
57	24
58	30
59	27
60	33
61	39
62	40
63	33
64	32
65	32
66	30
67	30
68	30
69	35
70	35
71	34
72	35
73	31
74	35
75	31
76	35
77	30
78	30
79	33
80	35
81	30
82	
83	27
84	24
85	21
86	22
87	23
88	22
89	20
90	24
91	20

	Control	Trtmnts
Min Humidity:	20	24
Max Humidity:	57	59
Avg Humidity:	36.16	40.67

QA: ARO 1/24/12
[initials] 1/13/12

TEST ORGANISM DRY WEIGHT AND ASH-FREE DRY WEIGHT (AFDW)

Project No: 60147216-445-(035-038)	TARE: Date/time: 12/30/11 @ 1440 Analyst: BP	Dried in Oven # 3 from Date: 12/30/11 Time: 1525 Oven °C: 83 to Date: 1/3/12 Time: 0820
Species: Echinochloa crusgalli Lot/Batch No.: 95-59	WET GROSS: Date/time: 12/30/11 @ 1520 Analyst: BP	Ashed in Furnace from Date:_____ Time: Furnace °C: ____ to Date:_____ Time:
Analytical Balance ID: SART #1	DRY GROSS: Date/time: 1/4/12 @ 1000 Analyst: TK	
	ASHED GROSS: Date/time: ~~1/3/11~~ Analyst:	Lot # 95-59

Indicate mean weight is **Dry Weight** or **AFDW** (Circle one)

Boat No.	Treatment	Rep	Tare Weight (g) (A)	Wet Gross Weight (g) (E)	Wet Net Weight (g) (F-A)	Dry Gross Weight (g) (B)	Dry Net Weight (g) (B-A)	Adjusted Dry Net Weight (g)[1]	Ashed Gross Weight (g) (D)	AFDW (g) (B-D)	Dry Wt./Wet Wt. Ratio	AFDW/ Wet Wt. Ratio	AFDW/Dry Wt. Ratio	
	Control	A	~~3.70768~~ 3.69416	8.20916	4.51500	4.92604	1.23188							
		B	3.66320	7.83536	4.17216	4.89508	1.23188							
		C	3.70550	8.09905	4.39355	4.99509	1.28959							
		D	3.70768	8.46645	4.75877	5.16900	1.46132							
Blank			~~3.70454~~ 3.70442			3.70445								

[1] Add in weight loss of blank boat, if appropriate.

① BP 12/30/11 ② TK 1/4/12 WP

FCETL QA Form No.141
Revision 1
Effective 09/10

QA: AR 01/24/12
1/13/12

TEST ORGANISM DRY WEIGHT AND ASH-FREE DRY WEIGHT (AFDW)

Project No: 60147216-445-(035-038)	TARE: Date/time: 12/16/11 @ 1435 Analyst: AD		Dried in Oven # 1 from Date: 12/16/11 Time: 1605 Oven °C: 85 to Date: 12/19/11 Time: 0910
Species: Echinochloa crusgalli Lot/Batch No.:	WET GROSS: Date/time: 12/16/11 @ 1500 Analyst: (START TIME) AD		Ashed in Furnace from Date: Time: Furnace °C: to Date: Time:
Analytical Balance ID: AND #2	DRY GROSS: Date/time: 12/19/11 @ 1640 Analyst:		
	ASHED GROSS: Date/time:	Analyst:	Lot #: 95-59

Indicate mean weight is **Dry Weight** or **AFDW** (Circle one)

Boat No.	Treatment	Rep	Tare Weight (g) (A)	Wet Gross Weight (g) (E)	Wet Net Weight (g) (E-A)	Dry Gross Weight (g) (B)	Dry Net Weight (g) (B-A)	Adjusted Dry Net Weight (g)[1]	Ashed Gross Weight (g) (D)	AFDW (g) (B-D)	Dry Wt./Wet Wt. Ratio	AFDW/Wet Wt. Ratio	AFDW/Dry Wt. Ratio	
	APG-06-MA-060311	A	3.7401	6.9813	3.2412	4.7395	0.9994							
		B	3.7142	7.1230	3.4088	4.6100	0.8958							
		C	3.7677	7.4465	3.6788	4.7812	1.0135							
		D	3.7377	9.1669	5.4292	5.1372	1.3995							
	APG-15-MA-060311	A	3.7457	① ~~8.15~~ 8.1234	4.3777	4.9604	1.2147							
		B	3.7635	7.8215	4.0580 ②	4.8745	1.1111							
		C	3.7458	8.7113	4.9655	5.1066	1.3608							
		D	3.7330	7.9147	4.1817	5.0577	1.3247							
	APG-02-MA-060311	A	3.7172	8.3776	4.6604	4.8888	1.1716							
		B	3.7156	7.8771	4.1615	4.7019	0.9863							
		C	3.7440	7.2769	3.5329	4.6671	0.9231							
		D	3.7702	7.0824	3.3122	4.7980	1.0278							
Blank			3.7040	3.7045		3.7045								

1/20/12

[1] Add in weight loss of blank boat, if appropriate.

① AD 12/16/11 E 8.1234   ② AD 12/16/11 IF. 4.0580

TEST ORGANISM DRY WEIGHT AND ASH-FREE DRY WEIGHT (AFDW)

QA: AEa 1/24/12
1/13/12

Project No: 60147216-445-(035-030)	TARE: Date/time: 12/16/11 @ 1435 Analyst: AD	Dried in Oven # 1 from Date: 12/16/11 Time: 1605 Oven °C: 85 to Date: 12/17/11 Time: 0910
Species: Echinochloa crusgalli Lot/Batch No.:	WET GROSS: Date/time: 12/16/11 @ 1500 (START TIME) Analyst: AD	Ashed in Furnace from Date:______ Time: Furnace °C: ____ to Date:______ Time:
Analytical Balance ID:	DRY GROSS: Date/time: Analyst:	
	ASHED GROSS: Date/time: Analyst:	Lot #: 95-59

Indicate mean weight is **Dry Weight** or **AFDW** (Circle one)

Boat No.	Treatment	Rep	Tare Weight (g) (A)	Wet Gross Weight (g) (E)	Wet Net Weight (g) (F-A)	Dry Gross Weight (g) (B)	Dry Net Weight (g) (B-A)	Adjusted Dry Net Weight (g)[1]	Ashed Gross Weight (g) (D)	AFDW (g) (B-D)	Dry Wt./Wet Wt. Ratio	AFDW/ Wet Wt. Ratio	AFDW/Dry Wt. Ratio	
	APG-16-MA-060311	A	3.6445	9.4690	5.8245	5.4061								
		Δ B	3.6559	10.4727	6.8168	5.5035								
		Δ C	3.6821	9.2480	5.5659	5.1908								
		D	3.7095	9.6372	5.9277	5.5413								
Blank														

[1] Add in weight loss of blank boat, if appropriate.

Δ plant material for replicate B was placed in weigh pan mark ~~16C~~ and ~~16B~~ plant material placed on replicate pan ~~C~~ B.
① C ① B

① AD 12/16/11 E

QA: AC 08/06/12

TEST ORGANISM LENGTHS, WEIGHTS, AND LOADING

Project Number: 60147216-445-(035-038) Species: Echinochloa crusgalli

Treatment	Rep	Tare Weight (g)	Wet Gross Weight (g)	Wet Net Weight (g)	No of Orig. Organisms	Mean WET Wt./ Original Organism (g)	Mean WET Wt./ Treatment (g) (Original)	Number of Surv. Organisms	Mean WET Wt./ Surviving Organism (g)	Mean WET Wt./ Treatment (g) (Surviving)
Control	A	3.69416	8.20916	4.51500	20	0.2258	0.2230	19	0.2376	0.2287
	B	3.66320	7.83536	4.17216	20	0.2086		19	0.2196	
	C	3.70550	8.09905	4.39355	20	0.2197		20	0.2197	
	D	3.70768	8.46645	4.75877	20	0.2379		20	0.2379	

Project Number: 60147216-445-(035-038) Species: Echinochloa crusgalli

Summary Statistics for Survival Data

N	Min	Max	SD	Mean	C.V.
4	0.950	1.0	0.0289	0.9750	2.961%

Summary Statistics for WET weight per Original Data

N	Min	Max	SD	Mean	C.V.
4	0.2086	0.2379	0.0122	0.2230	5.486%

Summary Statistics for WET weight per Surviving Data

N	Min	Max	SD	Mean	C.V.
4	0.2196	0.2379	0.0105	0.2287	4.583%

TEST ORGANISM LENGTHS, WEIGHTS, AND LOADING

Project Number: 60147216-445-(035-038) Species: Echinochloa crusgalli

QA: AC 03/06/12

Treatment	Rep	Tare Weight (g)	Wet Gross Weight (g)	Wet Net Weight (g)	No of Orig. Organisms	Mean WET Wt./ Original Organism (g)	Mean WET Wt./ Treatment (g) (Original)	Number of Surv. Organisms	Mean WET Wt./ Surviving Organism (g)	Mean WET Wt./ Treatment (g) (Surviving)
APG-06-MA-060311	A	3.7401	6.9813	3.2412	19	0.1706	0.1991	19	0.1706	0.1991
	B	3.7142	7.1230	3.4088	20	0.1704		20	0.1704	
	C	3.7677	7.4465	3.6788	20	0.1839		20	0.1839	
	D	3.7377	9.1669	5.4292	20	0.2715		20	0.2715	
APG-15-MA-060311	A	3.7457	8.1234	4.3777	19	0.2304	0.2140	18	0.2432	0.2172
	B	3.7635	7.8215	4.0580	20	0.2029		20	0.2029	
	C	3.7458	8.7113	4.9655	20	0.2483		20	0.2483	
	D	3.7330	7.9147	4.1817	24	0.1742		24	0.1742	
APG-02-MA-060311	A	3.7172	8.3776	4.6604	19	0.2453	0.1989	19	0.2453	0.1989
	B	3.7156	7.8771	4.1615	20	0.2081		20	0.2081	
	C	3.7440	7.2769	3.5329	20	0.1766		20	0.1766	
	D	3.7702	7.0824	3.3122	20	0.1656		20	0.1656	
APG-16-MA-060311	A	3.6445	9.4690	5.8245	19	0.3066	0.3055	19	0.3066	0.3055
	B	3.6559	10.4727	6.8168	20	0.3408		20	0.3408	
	C	3.6821	9.2480	5.5659	20	0.2783		20	0.2783	
	D	3.7095	9.6372	5.9277	20	0.2964		20	0.2964	

Project Number: 60147216-445-(035-038) Species: Echinochloa crusgalli

QA: AR 03/06/12

Summary Statistics for Survival Data

Treatment	N	Min	Max	Mean	SD	C.V.
APG-06-MA-060311	4	1.0	1.0	1.0000	0.0000	0.000%
APG-15-MA-060311	4	0.947	1.0	0.9868	0.0263	2.667%
APG-02-MA-060311	4	1.0	1.0	1.0000	0.0000	0.000%
APG-16-MA-060311	4	1.0	1.0	1.0000	0.0000	0.000%

Summary Statistics for Growth Data (wet wt per original)

Treatment	N	Min	Max	Mean	SD	C.V.
APG-06-MA-060311	4	0.1704	0.2715	0.1991	0.0486	24.433%
APG-15-MA-060311	4	0.1742	0.2483	0.2140	0.0324	15.141%
APG-02-MA-060311	4	0.1656	0.2453	0.1989	0.0358	17.985%
APG-16-MA-060311	4	0.2783	0.3408	0.3055	0.0263	8.604%

Summary Statistics for Growth Data (wet wt per surviving organism)

Treatment	N	Min	Max	Mean	SD	C.V.
APG-06-MA-060311	4	0.1704	0.2715	0.1991	0.0486	24.433%
APG-15-MA-060311	4	0.1742	0.2483	0.2172	0.0351	16.155%
APG-02-MA-060311	4	0.1656	0.2453	0.1989	0.0358	17.985%
APG-16-MA-060311	4	0.2783	0.3408	0.3055	0.0263	8.604%

QA:cw 04/30/12

TEST ORGANISM LENGTHS, WEIGHTS, AND LOADING

Project Number: 60147216-445-(035-038)   Species: Echinochloa crusgalli

Treatment	Rep	Tare Weight (g)	Dry Gross Weight (g)	Dry Net Weight (g)	Adjusted Net Weight (g)	No of Orig. Organisms	Mean DRY Wt./ Original Organism (g)	Mean DRY Wt./ Treatment (g) (Original)	Number of Surv. Organisms	Mean DRY Wt./ Surviving Organism (g)	Mean DRY Wt./ Treatment (g) (Surviving)
Control	A	3.69416	4.92604	1.23188	1.23188	20	0.0616	0.0652	19	0.0648	0.0668
	B	3.66320	4.89508	1.23188	1.23188	20	0.0616		19	0.0648	
	C	3.70550	4.99509	1.28959	1.28959	20	0.0645		20	0.0645	
	D	3.70768	5.16900	1.46132	1.46132	20	0.0731		20	0.0731	
Blank		3.70442	3.70445	0.00003							

Summary Statistics for Survival Data

N	Min	Max	Mean	SD	C.V.
4	0.950	1.0	0.9750	0.0289	2.961%

Summary Statistics for DRY weight per Original Data

N	Min	Max	Mean	SD	C.V.
4	0.0616	0.0731	0.0652	0.0054	8.328%

Summary Statistics for DRY weight per Surviving Data

N	Min	Max	Mean	SD	C.V.
4	0.0645	0.0731	0.0668	0.0042	6.254%

QA:CW 04/30/12

TEST ORGANISM LENGTHS, WEIGHTS, AND LOADING

Project Number: 60147216-445-(035-038) Species: Echinochloa crusgalli

Treatment	Rep	Tare Weight (g)	Dry Gross Weight (g)	Dry Net Weight (g)	Adjusted Net Weight (g)	No of Orig. Organisms	Mean DRY Wt./ Original Organism (g)	Mean DRY Wt./ Treatment (g) (Original)	Number of Surv. Organisms	Mean DRY Wt./ Surviving Organism (g)	Mean DRY Wt./ Treatment (g) (Surviving)
APG-06-MA-060311	A	3.7401	4.7395	0.9994	0.9994	19	0.0526	0.0545	19	0.0526	0.0545
	B	3.7142	4.6100	0.8958	0.8958	20	0.0448		20	0.0448	
	C	3.7677	4.7812	1.0135	1.0135	20	0.0507		20	0.0507	
	D	3.7377	5.1372	1.3995	1.3995	20	0.0700		20	0.0700	
APG-15-MA-060311	A	3.7457	4.9604	1.2147	1.2147	19	0.0639	0.0607	18	0.0675	0.0616
	B	3.7635	4.8745	1.1110	1.1110	20	0.0556		20	0.0556	
	C	3.7458	5.1066	1.3608	1.3608	20	0.0680		20	0.0680	
	D	3.7330	5.0577	1.3247	1.3247	24	0.0552		24	0.0552	
APG-02-MA-060311	A	3.7172	4.8888	1.1716	1.1716	19	0.0617	0.0521	19	0.0617	0.0521
	B	3.7156	4.7019	0.9863	0.9863	20	0.0493		20	0.0493	
	C	3.7440	4.6671	0.9231	0.9231	20	0.0462		20	0.0462	
	D	3.7702	4.7980	1.0278	1.0278	20	0.0514		20	0.0514	
APG-16-MA-060311	A	3.6445	5.4061	1.7616	1.7616	19	0.0927	0.0880	19	0.0927	0.0880
	B	3.6559	5.5035	1.8476	1.8476	20	0.0924		20	0.0924	
	C	3.6821	5.1908	1.5087	1.5087	20	0.0754		20	0.0754	
	D	3.7095	5.5413	1.8318	1.8318	20	0.0916		20	0.0916	
Blank		3.70400	3.70450	0.00050							

Project Number: 60147216-445-(035-038)   Species: Echinochloa crusgalli

AR 03/06/12
QA: CW 04/27/12

Summary Statistics for Survival Data

Treatment	N	Min	Max	Mean	SD	C.V.
APG-06-MA-060311	4	1.0	1.0	1.0000	0.0000	0.000%
APG-15-MA-060311	4	0.947	1.0	0.9868	0.0263	2.667%
APG-02-MA-060311	4	1.0	1.0	1.0000	0.0000	0.000%
APG-16-MA-060311	4	1.0	1.0	1.0000	0.0000	0.000%

Summary Statistics for Growth Data (dry wt per original)

Treatment	N	Min	Max	Mean	SD	C.V.
APG-06-MA-060311	4	0.0448	0.0700	0.0545	0.0108	19.872%
APG-15-MA-060311	4	0.0552	0.0680	0.0607	0.0064	10.472%
APG-02-MA-060311	4	0.0462	0.0617	0.0521	0.0067	12.871%
APG-16-MA-060311	4	0.0754	0.0927	0.0880	0.0084	9.554%

Summary Statistics for Growth Data (dry wt per surviving organism)

Treatment	N	Min	Max	Mean	SD	C.V.
APG-06-MA-060311	4	0.0448	0.0700	0.0545	0.0108	19.872%
APG-15-MA-060311	4	0.0552	0.0680	0.0616	0.0072	11.626%
APG-02-MA-060311	4	0.0462	0.0617	0.0521	0.0067	12.871%
APG-16-MA-060311	4	0.0754	0.0927	0.0880	0.0084	9.554%

Project No.: 60147216-445-(035-038)
Species: *Echinochloa crusgalli*

*2/20/12
QA: AR 01/24/12

Plant Length

Treatment	Plant No.	Length (cm or mm circle one)			
		Replicate			
		A	B	C	D
Control	1	270 ①	226	239	188
	2	252	202	225	204
	3	266	270	224	231
	4	246	260	283	251
	5	230	279	246	262
	6	276	209	277	260
	7	~~25.3~~ 253 ①	238	270	247
	8	~~25.3~~ 253 ①	207	242	276
	9	279	302	249	215
	10	274	245	270	275
	11	246	281	285	246
	12	258	248	230	206
	13	245	275	274	277
	14	188	268	291	260
	15	255	259	140	237
	16	307	211	290	290
	17	271	266	265	237
	18	285	190	271	286
	19	249	275	227	231
	20			② ~~①~~ ~~2904~~ 294	177
	Date	12/30/11	12/30/11	12/30/11	12/30/11
	Time	1500	1400	1500	1405
	Initials	G	K	W	W

① G 12/30/11 E
~~①~~ W 12/30/11 E
② ③

③ mm for WW 01/23/12 C

Project No.: 60147216-445-(035-038)
Species: *Echinochloa crusgalli*
Data for replicate A B C transcribed from the original data sheet
AR: AR 01/24/12
AR 2/20/12

Plant Length

Treatment	Plant No.	Length (cm or mm circle one)			
		Replicate			
		A	B	C	D
APG-06-MA-060311	1	156	231	193	275
	2	219	220	218	195
	3	208	232	234	278
	4	222	206	218	221
	5	243	254	198	304
	6	145	236	247	219
	7	197	191	263	253
	8	179	189	270	289
	9	177	153	227	305
	10	275	237	288	304
	11	193	247	229	209
	12	178	283	241	259
	13	254	202	233	285
	14	209	184	200	311
	15	221	188	175	257
	16	225	192	271	255
	17	224	144	157	260
	18	197	238	202	265
	19	156	213	239	152
	20		183	217	255
	Date	12/16/11	12/16/11	12/16/11	12/16/11
	Time	1430	1440	1440	1510
	Initials	AP	AP	BP	AP

Project No.: 60147216-445-____

Species: *Echinochloa crusgalli*

Data for replicate A, plants #1 to 7, transcribed from the original data sheet AR 02/19/12
B (all plants)
D (all plants) de 2/20/12

Plant Length

Treatment	Plant No.	Length (cm or mm circle one)			
		Replicate			
		A	B	C	D
APG-15-MA-060311	1	200	215	235	255
	2	205	245	274	246
	3	218	190	266	234
	4	254	208	268	260
	5	213	247	179	227
	6	202	223	192	204
	7	225	250	218	210
	8	227	195	267	186
	9	197	180	241	225
	10	245	282	242	202
	11	215	335	209	215
	12	220	216	226	239
	13	195	252	201	175
	14	250	192	258	224
	15	206	278	162	203
	16	205	279	220	225
	17	248	206	170	115
	18	210	294	226	199
	19		253	219	190
	20		237	188	237
	Date	12/16/12	12/16/11	12/16/11	12/16/11
	Time	1550	1600	1535	1600
	Initials	[initials]	[initials]	AP/BP	[initials]

cont

215
257
192
206

Project No.: 60147216-445-____
Species: *Echinochloa crusgalli*

Data for replicates A, D were transcribed from the original data sheet

2/20/12
QA: 1/24/12

Plant Length

Treatment	Plant No.	Length (cm or mm circle one)			
		Replicate			
		A	B	C	D
APG-02-MA-060311	1	247	159	206	169
	2	242	235	242	210
	3	280	179	221	180
	4	287	213	269	164
	5	234	167	206	196
	6	308	199	209	232
	7	256	260	294	188
	8	238	267	229	147
	9	260	189	236	119
	10	247	198	241	184
	11	290	235	210	205
	12	205	260	256	220
	13	236	274	192	223
	14	269	226	196	206
	15	270	251	197	214
	16	239	201	211	225
	17	212	240	219	170
	18	241	236	195	230
	19	257	252	201	238
	20		241	248	202
	Date	12/16/11	12/16/11	12/16/11	12/16/11
	Time	1435	1600	1525	1520
	Initials	BP	BP	BP	AP

Project No.: 60147216-445-____
Species: *Echinochloa crusgalli*
Data for replicate B were transcribed from the original data sheet

Plant Length

2/20/12
AA: AA 01/24/12

Treatment	Plant No.	Length (cm or mm circle one) Replicate A	B	C	D
APG-16-MA-060311	1	251	212	312	219
	2	248	285	213	261
	3	360	245	216	304
	4	221	265	272	293
	5	286	304	276	319
	6	275	291	248	323
	7	241	263	233	256
	8	272	249	238	236
	9	286	252	277	272
	10	265	288	247	187
	11	266	297	281	280
	12	296	275	284	302
	13	242	315	212	271
	14	246	258	257	262
	15	257	301	241	260
	16	287	241	294	245
	17	264	280	269	289
	18	271	285	240	266
	19	284	305	256	242
	20		300	221	216
	Date	12/16/11	12/16/11	12/16/11	12/16/11
	Time	1425	1430	1445	1510
	Initials	cw	W	cw	cw

Project No.: 60147216-445-(035-038)
Species: Echinochloa crusgalli

dk 4/27/12
QA: cw 04/30/12

Plant No.	Length in mm of (Controls)			
	Replicate			
	A	B	C	D
1	270	226	239	188
2	252	202	225	204
3	266	270	224	231
4	246	260	283	251
5	230	279	246	262
6	276	209	277	260
7	253	238	270	247
8	253	207	242	276
9	279	302	249	215
10	274	245	270	275
11	246	281	285	246
12	258	248	230	206
13	245	275	274	277
14	188	268	291	260
15	255	259	140	237
16	307	211	290	290
17	271	266	265	237
18	285	190	271	286
19	249	275	227	231
20			294	177

Sum:	4903	4711	5092	4856	
Min:	188	190	140	177	
Max:	307	302	294	290	
Average:	258.0526	247.9474	254.6	242.8	250.85
STD:	24.54582	32.09443	35.84381	32.25654	

4/27/12
QA:CW 04/30/12

Plant No.	Length in mm (APG - 02-MA-060311)			
	Replicate			
	A	B	C	D
1	247	159	206	169
2	242	235	242	210
3	280	179	221	180
4	287	213	269	164
5	234	167	206	196
6	308	199	209	232
7	256	260	294	188
8	238	267	229	147
9	260	189	236	119
10	247	198	241	184
11	290	235	210	205
12	205	260	256	220
13	236	274	192	223
14	269	226	196	206
15	270	251	197	214
16	239	201	211	225
17	212	240	219	170
18	241	236	195	230
19	257	252	201	238
20		241	248	202

Sum:	4818	4482	4478	3922	
Min:	205	159	192	119	
Max:	308	274	294	238	
Average:	253.5789	224.1	223.9	196.1	224.4197
STD:	26.12431	34.07716	27.61178	31.05326	

dk 4/27/12
QA:cw 04/30/12

Plant No.	Length in mm (APG - 06 - MA -060311)			
	Replicate			
	A	B	C	D
1	156	231	193	275
2	219	220	218	195
3	208	232	234	278
4	222	206	218	221
5	243	254	198	304
6	145	236	247	219
7	197	191	263	253
8	179	189	270	289
9	177	153	227	305
10	275	237	288	304
11	193	247	229	209
12	178	283	241	259
13	254	202	233	285
14	209	184	200	311
15	221	188	175	257
16	225	192	271	255
17	224	144	157	260
18	197	238	202	265
19	156	213	239	152
20		183	217	255

Sum:	3878	4223	4520	5151	
Min:	145	144	157	152	
Max:	275	283	288	311	
Average:	204.1053	211.15	226	257.55	224.7013
STD:	34.25378	34.43571	33.10907	41.17929	

4/27/12
QA/CW 04/30/12

Plant No.	Length in mm (APG - 15 - MA - 060311)			
	Replicate			
	A	B	C	D
1	200	215	235	255
2	205	245	274	246
3	218	190	266	234
4	254	208	268	260
5	213	247	179	227
6	202	223	192	204
7	225	250	218	210
8	227	195	267	186
9	187	180	241	225
10	245	282	242	202
11	215	335	209	215
12	220	216	226	239
13	195	252	201	175
14	250	192	258	224
15	206	278	162	203
16	205	279	220	225
17	248	206	170	115
18	210	294	226	199
19		253	219	190
20		237	188	237
21				215
22				257
23				192
24				206

Sum:	3925	4777	4461	5141	
Min:	187	180	162	115	
Max:	254	335	274	260	
Average:	218.0556	238.85	223.05	214.2083	223.541
STD:	19.90114	40.54792	33.92325	31.32714	

*4/27/12
QA: CW 04/30/12

Plant No.	Length in mm (APG - 16 - MA - 060311)			
	Replicate			
	A	B	C	D
1	251	212	312	219
2	248	285	213	261
3	360	245	216	304
4	221	265	272	293
5	286	304	276	319
6	275	291	248	323
7	241	263	233	256
8	272	249	238	236
9	286	252	277	272
10	265	288	247	187
11	266	297	281	280
12	296	275	284	302
13	242	315	212	271
14	246	258	257	262
15	257	301	241	260
16	287	241	294	245
17	264	280	269	289
18	271	285	240	266
19	284	305	256	242
20		300	221	216

Sum:	5118	5511	5087	5303	
Min:	221	212	212	187	
Max:	360	315	312	323	
Average:	269.3684	275.55	254.35	265.15	266.1046
STD:	29.33373	26.68821	28.36839	35.05075	

Project No.: 60147216-445-(035-038) **Number of plants at intitiation and termination**
Species: *Echinochloa crusgalli*

* 7/23/12
QA: mm 07/23/12

Conc.	Test Replicate	Beginning	End	Percent Survival
Control	A	20	19	97.5
	B	20	19	
	C	20	20	
	D	20	20	
APG-06-MA-060311	A	20	19[a]	100
	B	20	20	
	C	20	20	
	D	20	20	
APG-15-MA-060311	A	20	18[a]	98.7
	B	20	20	
	C	20	20	
	D	24	24[b]	
APG-02-MA-060311	A	20	19[a]	100
	B	20	20	
	C	20	20	
	D	20	20	
APG-16-MA-060311	A	20	19[a]	100
	B	20	20	
	C	20	20	
	D	20	20	

[a] One plant was sacrificed on day 66 from replicate "A" for analysis of weight and length and was excluded from analysis of survival, length, and weight analyses.

[b] On the day of test takedown, 24 *Echinochloa crusgalli* plants were recorded and measured for length and weight analysis.

APPENDIX E

Statistical Analysis

Toxstat Version 3.5
Study # 60147216-445-(035-038)
ESTCP
Echinochloa crusgalli
Summary Statistics for Plant Length (mm) (Compared to Site Control)

Page_____of_____

*12/13/12
QA: AR 12/29/12

Title: 60147216-445-(035-038)
File: 445lengt.dat Transform: NO TRANSFORMATION

Summary Statistics on Data TABLE 1 of 2

GRP	IDENTIFICATION	N	MIN	MAX	MEAN
1	APG-15	4	214.2000	238.8500	223.5375
2	APG-02	4	196.1000	253.5700	224.4175
3	APG-06	4	204.1100	257.5500	224.7025
4	APG-16	4	254.3500	275.5500	266.1025

Title: 60147216-445-(035-038)
File: 445lengt.dat Transform: NO TRANSFORMATION

Summary Statistics on Data TABLE 2 of 2

GRP	IDENTIFICATION	VARIANCE	SD	SEM	C.V. %
1	APG-15	117.3373	10.8322	5.4161	4.8458
2	APG-02	550.7059	23.4671	11.7336	10.4569
3	APG-06	562.7877	23.7231	11.8616	10.5576
4	APG-16	79.6317	8.9237	4.4618	3.3535

Toxstat Version 3.5 Page_____of_____
Study # 60147216-445-(035-038)
ESTCP
Echinochloa crusgalli
Determination of NOEC and LOEC for Plant Length (mm) (Compared to Site Control)

12|13|12
QA: AR 12/29/12

```
Title:  60147216-445-(035-038)
File:      445lengt.dat              Transform:              NO TRANSFORMATION

                    Shapiro - Wilk's Test for Normality
---------------------------------------------------------------------------

     D = 3931.3877
     W =    0.9534

     Critical W  = 0.8440 (alpha = 0.01 , N = 16)
              W  = 0.8870 (alpha = 0.05 , N = 16)

---------------------------------------------------------------------------

Data PASS normality test (alpha = 0.01). Continue analysis.


Title:  60147216-445-(035-038)
File:      445lengt.dat              Transform:              NO TRANSFORMATION

                 Bartlett's Test for Homogeneity of Variance
---------------------------------------------------------------------------

Calculated B1 statistic =  3.6372              (p-value = 0.3034)

Data PASS B1 homogeneity test at 0.01 level. Continue analysis.

---------------------------------------------------------------------------

Critical B = 11.3449  (alpha = 0.01, df =  3)
           =  7.8147  (alpha = 0.05, df =  3)
```

Toxstat Version 3.5 Page____of____
Study # 60147216-445-(035-038)
ESTCP
Echinochloa crusgalli
Determination of NOEC, LOEC and PMSD for Length (mm) (Compared to Site Control)

ds 1/8/13
QA: cw 01/08/13

Title: 60147216-445-(035-038)
File: 445lengt.dat Transform: NO TRANSFORMATION

ANOVA Table

SOURCE	DF	SS	MS	F
Between	3	5265.5913	1755.1971	5.3575
Within (Error)	12	3931.3877	327.6156	
Total	15	9196.9790		

(p-value = 0.0142)

Critical F = 5.9525 (alpha = 0.01, df = 3,12)
= 3.4903 (alpha = 0.05, df = 3,12)

Since F > Critical F REJECT Ho: All equal (alpha = 0.05)

Title: 60147216-445-(035-038)
File: 445lengt.dat Transform: NO TRANSFORMATION

Dunnett's Test - TABLE 1 OF 2 Ho:Control=Treatment

GROUP	IDENTIFICATION	TRANSFORMED MEAN	MEAN CALCULATED IN ORIGINAL UNITS	T STAT	SIG 0.05
1	APG-15	223.5375	223.5375		
2	APG-02	224.4175	224.4175	0.0688	
3	APG-06	224.7025	224.7025	0.0910	
4	APG-16	266.1025	266.1025	3.3257	*

Dunnett critical value = 2.6800 (2 Tailed, alpha = 0.05, df = 3,12)

Title: 60147216-445-(035-038)
File: 445lengt.dat Transform: NO TRANSFORMATION

Dunnett's Test - TABLE 2 OF 2 Ho:Control=Treatment

GROUP	IDENTIFICATION	NUM OF REPS	MIN SIG DIFF (IN ORIG. UNITS)	% OF CONTROL	DIFFERENCE FROM CONTROL
1	APG-15	4			
2	APG-02	4	34.3006	15.3	0.8800
3	APG-06	4	34.3006	15.3	1.1650
4	APG-16	4	34.3006	15.3	42.5650

Toxstat Version 3.5 Page_____of_____
Study # 60147216-445-(035-038) QA: cw 01\08\13
ESTCP
Echinochloa crusgalli
Summary Statistics for Length (mm) per Original Organism (Using Lab Control)

Title: 60147216-445-(035-038)
File: length.dat Transform: NO TRANSFORMATION

Summary Statistics on Data TABLE 1 of 2

GRP	IDENTIFICATION	N	MIN	MAX	MEAN
1	Control	4	242.8000	258.0500	250.8500
2	APG-02	4	196.1000	253.5800	224.4200
3	APG-06	4	204.1000	257.5500	224.7000
4	APG-15	4	214.2100	238.8500	223.5425
5	APG-16	4	254.3500	275.5500	266.1050

Title: 60147216-445-(035-038)
File: length.dat Transform: NO TRANSFORMATION

Summary Statistics on Data TABLE 2 of 2

GRP	IDENTIFICATION	VARIANCE	SD	SEM	C.V. %
1	Control	46.3717	6.8097	3.4048	2.7146
2	APG-02	550.9003	23.4713	11.7356	10.4586
3	APG-06	562.9250	23.7260	11.8630	10.5590
4	APG-15	117.2385	10.8277	5.4138	4.8437
5	APG-16	79.6534	8.9249	4.4624	3.3539

Determination of NOEC, LOEC Length (mm) per Original Organism (Using Lab Control)

```
Title:  60147216-445-(035-038)
File:        length.dat            Transform:            NO TRANSFORMATION

                    Shapiro - Wilk's Test for Normality
-----------------------------------------------------------------------------

     D = 4071.2666
     W =    0.9543

     Critical W  = 0.8680 (alpha = 0.01 , N = 20)
              W  = 0.9050 (alpha = 0.05 , N = 20)

-----------------------------------------------------------------------------

Data PASS normality test (alpha = 0.01). Continue analysis.


Title:  60147216-445-(035-038)
File:        length.dat            Transform:            NO TRANSFORMATION

                 Bartlett's Test for Homogeneity of Variance
-----------------------------------------------------------------------------

Calculated B1 statistic =  6.3397              (p-value = 0.1752)

Data PASS B1 homogeneity test at 0.01 level. Continue analysis.

-----------------------------------------------------------------------------

Critical B = 13.2767  (alpha = 0.01, df =  4)
           =  9.4877  (alpha = 0.05, df =  4)
```

Toxstat Version 3.5 Page_____of_____
Study # 60147216-445-(035-038)
ESTCP
Echinochloa crusgalli
Determination of NOEC, LOEC and PMSD for Length (mm) per Original Organism (Using Lab Control)

JW 1/8/13
QA: CO 01/08/13

Title: 60147216-445-(035-038)
File: length.dat Transform: NO TRANSFORMATION

ANOVA Table

SOURCE	DF	SS	MS	F
Between	4	6101.2399	1525.3100	5.6198
Within (Error)	15	4071.2666	271.4178	
Total	19	10172.5065		

(p-value = 0.0057)

Critical F = 4.8932 (alpha = 0.01, df = 4,15)
= 3.0556 (alpha = 0.05, df = 4,15)

Since F > Critical F REJECT Ho: All equal (alpha = 0.05)

Title: 60147216-445-(035-038)
File: length.dat Transform: NO TRANSFORMATION

Dunnett's Test - TABLE 1 OF 2 Ho:Control=Treatment

GROUP	IDENTIFICATION	TRANSFORMED MEAN	MEAN CALCULATED IN ORIGINAL UNITS	T STAT	SIG 0.05
1	Control	250.8500	250.8500		
2	APG-02	224.4200	224.4200	2.2688	
3	APG-06	224.7000	224.7000	2.2447	
4	APG-15	223.5425	223.5425	2.3441	
5	APG-16	266.1050	266.1050	1.3095	

Dunnett critical value = 2.7300 (2 Tailed, alpha = 0.05, df = 4,15)

Title: 60147216-445-(035-038)
File: length.dat Transform: NO TRANSFORMATION

Dunnett's Test - TABLE 2 OF 2 Ho:Control=Treatment

GROUP	IDENTIFICATION	NUM OF REPS	MIN SIG DIFF (IN ORIG. UNITS)	% OF CONTROL	DIFFERENCE FROM CONTROL
1	Control	4			
2	APG-02	4	31.8029	12.7	26.4300
3	APG-06	4	31.8029	12.7	26.1500
4	APG-15	4	31.8029	12.7	27.3075
5	APG-16	4	31.8029	12.7	15.2550

Toxstat Version 3.5
Study # 60147216-445-(035-038)
ESTCP
Echinochloa crusgalli
Summary Statistics for WET Weight per Original Organism (Compared to Site Control)

Page____of_____

QA:CW 12/13/12
CK 12/12/12

Title: 60147216-445-(035-038)
File: 445wetpt.dat   Transform: NO TRANSFORMATION

Summary Statistics on Data   TABLE 1 of 2

GRP	IDENTIFICATION	N	MIN	MAX	MEAN
1	APG-15	4	0.1742	0.2483	0.2140
2	APG-02	4	0.1656	0.2453	0.1989
3	APG-06	4	0.1704	0.2715	0.1991
4	APG-16	4	0.2783	0.3408	0.3055

Title: 60147216-445-(035-038)
File: 445wetpt.dat   Transform: NO TRANSFORMATION

Summary Statistics on Data   TABLE 2 of 2

GRP	IDENTIFICATION	VARIANCE	SD	SEM	C.V. %
1	APG-15	0.0011	0.0324	0.0162	15.1519
2	APG-02	0.0013	0.0358	0.0179	17.9963
3	APG-06	0.0024	0.0487	0.0243	24.4492
4	APG-16	0.0007	0.0263	0.0131	8.5975

Toxstat Version 3.5 Page____of____
Study # 60147216-445-(035-038)
ESTCP
Echinochloa crusgalli
Determination of NOEC and LOEC for WET Weight per Original Organism (Compared to Site Control)

QA:CW 12/13/12
12/12/12

```
Title:   60147216-445-(035-038)
File:       445wetpt.dat              Transform:              NO TRANSFORMATION

                       Shapiro - Wilk's Test for Normality
-------------------------------------------------------------------------------

     D =    0.0162
     W =    0.9161

     Critical W  = 0.8440 (alpha = 0.01 , N = 16)
              W  = 0.8870 (alpha = 0.05 , N = 16)

-------------------------------------------------------------------------------

Data PASS normality test (alpha = 0.01). Continue analysis.


Title:   60147216-445-(035-038)
File:       445wetpt.dat              Transform:              NO TRANSFORMATION

                    Bartlett's Test for Homogeneity of Variance
-------------------------------------------------------------------------------

Calculated B1 statistic =  1.0673                (p-value = 0.7850)

Data PASS B1 homogeneity test at 0.01 level. Continue analysis.

-------------------------------------------------------------------------------

Critical B = 11.3449  (alpha = 0.01, df =  3)
           =  7.8147  (alpha = 0.05, df =  3)
```

Toxstat Version 3.5
Study # 60147216-445-(035-038)
ESTCP
Echinochloa crusgalli
Determination of NOEC, LOEC and PMSD for WET Weight per Original Organism (Compared to Site Control)

QA:CW 01\08\13
1|8|13

Title: 60147216-445-(035-038)
File: 445wetpt.dat Transform: NO TRANSFORMATION

ANOVA Table

SOURCE	DF	SS	MS	F
Between	3	0.0315	0.0105	7.7967
Within (Error)	12	0.0162	0.0013	
Total	15	0.0477		

(p-value = 0.0038)

Critical F = 5.9525 (alpha = 0.01, df = 3,12)
= 3.4903 (alpha = 0.05, df = 3,12)

Since F > Critical F REJECT Ho: All equal (alpha = 0.05)

Title: 60147216-445-(035-038)
File: 445wetpt.dat Transform: NO TRANSFORMATION

Dunnett's Test - TABLE 1 OF 2 Ho:Control=Treatment

GROUP	IDENTIFICATION	TRANSFORMED MEAN	MEAN CALCULATED IN ORIGINAL UNITS	T STAT	SIG 0.05
1	APG-15	0.2140	0.2140		
2	APG-02	0.1989	0.1989	0.5797	
3	APG-06	0.1991	0.1991	0.5720	
4	APG-16	0.3055	0.3055	3.5274	*

Dunnett critical value = 2.6800 (2 Tailed, alpha = 0.05, df = 3,12)

Title: 60147216-445-(035-038)
File: 445wetpt.dat Transform: NO TRANSFORMATION

Dunnett's Test - TABLE 2 OF 2 Ho:Control=Treatment

GROUP	IDENTIFICATION	NUM OF REPS	MIN SIG DIFF (IN ORIG. UNITS)	% OF CONTROL	DIFFERENCE FROM CONTROL
1	APG-15	4			
2	APG-02	4	0.0696	32.5	0.0150
3	APG-06	4	0.0696	32.5	0.0149
4	APG-16	4	0.0696	32.5	0.0916

Toxstat Version 3.5 Page_____of_____
Study # 60147216-445-(035-038) AA:CW 01\08\13
ESTCP
Echinochloa crusgalli
Summary Statistics for WET Weight per Original Organism (Using Lab Control)

Title: 60147216-44-(035-038)
File: plantcon.dat Transform: NO TRANSFORMATION

Summary Statistics on Data TABLE 1 of 2

GRP	IDENTIFICATION	N	MIN	MAX	MEAN
1	Control	4	0.2086	0.2379	0.2230
2	APG-15	4	0.1742	0.2483	0.2140
3	APG-06	4	0.1704	0.2715	0.1991
4	APG-02	4	0.1656	0.2453	0.1989
5	APG-16	4	0.2783	0.3408	0.3055

Title: 60147216-44-(035-038)
File: plantcon.dat Transform: NO TRANSFORMATION

Summary Statistics on Data TABLE 2 of 2

GRP	IDENTIFICATION	VARIANCE	SD	SEM	C.V. %
1	Control	0.0001	0.0122	0.0061	5.4805
2	APG-15	0.0011	0.0324	0.0162	15.1519
3	APG-06	0.0024	0.0487	0.0243	24.4492
4	APG-02	0.0013	0.0358	0.0179	17.9963
5	APG-16	0.0007	0.0263	0.0131	8.5975

Toxstat Version 3.5 Page_____of_____
Study # 60147216-445-(035-038) OA:CW 01/08/13
ESTCP
Echinochloa crusgalli
Determination of NOEC and LOEC for WET Weight per Original Organism (Using Lab Control)

Title: 60147216-44-(035-038)
File: plantcon.dat Transform: NO TRANSFORMATION

Shapiro - Wilk's Test for Normality

D = 0.0166
W = 0.9371

Critical W = 0.8680 (alpha = 0.01 , N = 20)
W = 0.9050 (alpha = 0.05 , N = 20)

Data PASS normality test (alpha = 0.01). Continue analysis.

Title: 60147216-44-(035-038)
File: plantcon.dat Transform: NO TRANSFORMATION

Bartlett's Test for Homogeneity of Variance

Calculated B1 statistic = 4.3041 (p-value = 0.3664)

Data PASS B1 homogeneity test at 0.01 level. Continue analysis.

Critical B = 13.2767 (alpha = 0.01, df = 4)
= 9.4877 (alpha = 0.05, df = 4)

Toxstat Version 3.5 Page_____of_____
Study # 60147216-445-(035-038)
ESTCP
Echinochloa crusgalli
Determination of NOEC, LOEC and PMSD for WET Weight per Original Organism (Using Lab Control)

dk 1/8/13
QA: CW 01/08/13

Title: 60147216-44-(035-038)
File: plantcon.dat Transform: NO TRANSFORMATION

ANOVA Table

SOURCE	DF	SS	MS	F
Between	4	0.0317	0.0079	7.1417
Within (Error)	15	0.0166	0.0011	
Total	19	0.0483		

(p-value = 0.0020)

Critical F = 4.8932 (alpha = 0.01, df = 4,15)
= 3.0556 (alpha = 0.05, df = 4,15)

Since F > Critical F REJECT Ho: All equal (alpha = 0.05)

Title: 60147216-44-(035-038)
File: plantcon.dat Transform: NO TRANSFORMATION

Dunnett's Test - TABLE 1 OF 2 Ho:Control=Treatment

GROUP	IDENTIFICATION	TRANSFORMED MEAN	MEAN CALCULATED IN ORIGINAL UNITS	T STAT	SIG 0.05
1	Control	0.2230	0.2230		
2	APG-15	0.2140	0.2140	0.3845	
3	APG-06	0.1991	0.1991	1.0153	
4	APG-02	0.1989	0.1989	1.0238	
5	APG-16	0.3055	0.3055	3.5058	*

Dunnett critical value = 2.7300 (2 Tailed, alpha = 0.05, df = 4,15)

Title: 60147216-44-(035-038)
File: plantcon.dat Transform: NO TRANSFORMATION

Dunnett's Test - TABLE 2 OF 2 Ho:Control=Treatment

GROUP	IDENTIFICATION	NUM OF REPS	MIN SIG DIFF (IN ORIG. UNITS)	% OF CONTROL	DIFFERENCE FROM CONTROL
1	Control	4			
2	APG-15	4	0.0643	28.8	0.0091
3	APG-06	4	0.0643	28.8	0.0239
4	APG-02	4	0.0643	28.8	0.0241
5	APG-16	4	0.0643	28.8	0.0825

Toxstat Version 3.5
Study # 60147216-445-(035-038)
ESTCP
Echinochloa crusgalli
Summary Statistics for DRY Weight per Original Organism (Compared to Site Control)

Page____of______

QA:CW 12\13\12
de 12|12|12

Title: 60147216-445-(035-038)
File: 445drypt.dat   Transform: NO TRANSFORMATION

Summary Statistics on Data   TABLE 1 of 2

GRP	IDENTIFICATION	N	MIN	MAX	MEAN
1	APG-15	4	0.0552	0.0680	0.0607
2	APG-02	4	0.0462	0.0617	0.0522
3	APG-06	4	0.0448	0.0700	0.0545
4	APG-16	4	0.0754	0.0927	0.0880

Title: 60147216-445-(035-038)
File: 445drypt.dat   Transform: NO TRANSFORMATION

Summary Statistics on Data   TABLE 2 of 2

GRP	IDENTIFICATION	VARIANCE	SD	SEM	C.V. %
1	APG-15	0.0000	0.0063	0.0032	10.4144
2	APG-02	0.0000	0.0067	0.0034	12.8771
3	APG-06	0.0001	0.0108	0.0054	19.8771
4	APG-16	0.0001	0.0084	0.0042	9.5762

Toxstat Version 3.5 Page____of_____
Study # 60147216-445-(035-038)
ESTCP
Echinochloa crusgalli
Determination of NOEC and LOEC for DRY Weight per Original Organism (Compared to Site Control)

QA:CJ 12/13/12
12/12/12

```
Title:  60147216-445-(035-038)
File:      445drypt.dat            Transform:              NO TRANSFORMATION

                    Shapiro - Wilk's Test for Normality
---------------------------------------------------------------------------

     D =    0.0008
     W =    0.9799

     Critical W  = 0.8440 (alpha = 0.01 , N = 16)
              W  = 0.8870 (alpha = 0.05 , N = 16)

---------------------------------------------------------------------------

Data PASS normality test (alpha = 0.01). Continue analysis.


Title:  60147216-445-(035-038)
File:      445drypt.dat            Transform:              NO TRANSFORMATION

                 Bartlett's Test for Homogeneity of Variance
---------------------------------------------------------------------------

Calculated B1 statistic =  0.9883               (p-value = 0.8041)

Data PASS B1 homogeneity test at 0.01 level. Continue analysis.

---------------------------------------------------------------------------

Critical B = 11.3449  (alpha = 0.01, df =  3)
           =  7.8147  (alpha = 0.05, df =  3)
```

dk 1/8/13
QA:CW 01/08/13

Toxstat Version 3.5 Page____of____
Study # 60147216-445-(035-038)
ESTCP
Echinochloa crusgalli
Determination of NOEC, LOEC and PMSD for DRY Weight per Original Organism (Compared to Site Control)

Title: 60147216-445-(035-038)
File: 445drypt.dat Transform: NO TRANSFORMATION

ANOVA Table

SOURCE	DF	SS	MS	F
Between	3	0.0033	0.0011	15.9556
Within (Error)	12	0.0008	0.0001	
Total	15	0.0041		

(p-value = 0.0002)

Critical F = 5.9525 (alpha = 0.01, df = 3,12)
= 3.4903 (alpha = 0.05, df = 3,12)

Since F > Critical F REJECT Ho: All equal (alpha = 0.05)

Title: 60147216-445-(035-038)
File: 445drypt.dat Transform: NO TRANSFORMATION

Dunnett's Test - TABLE 1 OF 2 Ho:Control=Treatment

GROUP	IDENTIFICATION	TRANSFORMED MEAN	MEAN CALCULATED IN ORIGINAL UNITS	T STAT	SIG 0.05
1	APG-15	0.0607	0.0607		
2	APG-02	0.0522	0.0522	1.4579	
3	APG-06	0.0545	0.0545	1.0517	
4	APG-16	0.0880	0.0880	4.6772	*

Dunnett critical value = 2.6800 (2 Tailed, alpha = 0.05, df = 3,12)

Title: 60147216-445-(035-038)
File: 445drypt.dat Transform: NO TRANSFORMATION

Dunnett's Test - TABLE 2 OF 2 Ho:Control=Treatment

GROUP	IDENTIFICATION	NUM OF REPS	MIN SIG DIFF (IN ORIG. UNITS)	% OF CONTROL	DIFFERENCE FROM CONTROL
1	APG-15	4			
2	APG-02	4	0.0157	25.8	0.0085
3	APG-06	4	0.0157	25.8	0.0061
4	APG-16	4	0.0157	25.8	0.0274

Toxstat Version 3.5
Study # 60147216-445-(035-038)
ESTCP
Echinochloa crusgalli
Summary Statistics for DRY Weight per Original Organism (Using Lab Control)

Page____of____
QA:CU 01/08/13

Title: 60147216-445-(035-038)
File: dry.dat Transform: NO TRANSFORMATION

Summary Statistics on Data TABLE 1 of 2

GRP	IDENTIFICATION	N	MIN	MAX	MEAN
1	Control	4	0.0616	0.0731	0.0652
2	APG-02	4	0.0462	0.0617	0.0522 (0.5215)
3	APG-06	4	0.0448	0.0700	0.0545
4	APG-15	4	0.0552	0.0680	0.0607
5	APG-16	4	0.0754	0.0927	0.0880

Title: 60147216-445-(035-038)
File: dry.dat Transform: NO TRANSFORMATION

Summary Statistics on Data TABLE 2 of 2

GRP	IDENTIFICATION	VARIANCE	SD	SEM	C.V. %
1	Control	0.0000	0.0054	0.0027	8.3454
2	APG-02	0.0000	0.0067	0.0034	12.8771
3	APG-06	0.0001	0.0108	0.0054	19.8771
4	APG-15	0.0000	0.0063	0.0032	10.4144
5	APG-16	0.0001	0.0084	0.0042	9.5762

Toxstat Version 3.5 Page_____of_____
Study # 60147216-445-(035-038) QA:CW 01\08\13
ESTCP
Echinochloa crusgalli
Determination of NOEC and LOEC for DRY Weight per Original Organism (Using Lab Control)

```
Title:  60147216-445-(035-038)
File:             dry.dat              Transform:              NO TRANSFORMATION

                    Shapiro - Wilk's Test for Normality
-----------------------------------------------------------------------------

     D =    0.0009
     W =    0.9745

     Critical W  = 0.8680 (alpha = 0.01 , N = 20)
              W  = 0.9050 (alpha = 0.05 , N = 20)

-----------------------------------------------------------------------------

Data PASS normality test (alpha = 0.01). Continue analysis.


Title:  60147216-445-(035-038)
File:             dry.dat              Transform:              NO TRANSFORMATION

                 Bartlett's Test for Homogeneity of Variance
-----------------------------------------------------------------------------

Calculated B1 statistic =  1.6159              (p-value = 0.8059)

Data PASS B1 homogeneity test at 0.01 level. Continue analysis.

-----------------------------------------------------------------------------

Critical B = 13.2767  (alpha = 0.01, df =  4)
           =  9.4877  (alpha = 0.05, df =  4)
```

Toxstat Version 3.5 Page_____of_____
Study # 60147216-445-(035-038)
ESTCP
Echinochloa crusgalli
Determination of NOEC, LOEC and PMSD for ~~WET~~ Dry ① Weight per Original Organism (Using Lab Control)

dr 1/8/13
QA: cw 01/08/13

Title: 60147216-445-(035-038)
File: plantdry.doc Transform: NO TRANSFORMATION

ANOVA Table

SOURCE	DF	SS	MS	F
Between	4	0.0033	0.0008	13.5218
Within (Error)	15	0.0009	0.0001	
Total	19	0.0042		

(p-value = 0.0001)

Critical F = 4.8932 (alpha = 0.01, df = 4,15)
= 3.0556 (alpha = 0.05, df = 4,15)

Since F > Critical F REJECT Ho: All equal (alpha = 0.05)

Title: 60147216-445-(035-038)
File: plantdry.doc Transform: NO TRANSFORMATION

Dunnett's Test - TABLE 1 OF 2 Ho:Control=Treatment

GROUP	IDENTIFICATION	TRANSFORMED MEAN	MEAN CALCULATED IN ORIGINAL UNITS	T STAT	SIG 0.05
1	Control	0.0652	0.0652		
2	APG-15	0.0607	0.0607	0.8218	
3	APG-06	0.0545	0.0545	1.9388	
4	APG-02	0.0522	0.0522	2.3702	
5	APG-16	0.0880	0.0880	4.1455	*

Dunnett critical value = 2.7300 (2 Tailed, alpha = 0.05, df = 4,15)

Title: 60147216-445-(035-038)
File: plantdry.doc Transform: NO TRANSFORMATION

Dunnett's Test - TABLE 2 OF 2 Ho:Control=Treatment

GROUP	IDENTIFICATION	NUM OF REPS	MIN SIG DIFF (IN ORIG. UNITS)	% OF CONTROL	DIFFERENCE FROM CONTROL
1	Control	4			
2	APG-15	4	0.0150	23.1	0.0045
3	APG-06	4	0.0150	23.1	0.0107
4	APG-02	4	0.0150	23.1	0.0130
5	APG-16	4	0.0150	23.1	0.0228

① dr 1/8/13, E

Toxstat Version 3.5 Page____of____
Study # 60147216-445-(035-038)
ESTCP
Echinochloa crusgalli
Summary Statistics for Plant Nutrient: BORON (mg/kg) using Lab Control

12/14/12
QA: CW 12/14/12

Title: 60147216-445-(035-038)
File: boron2.dat Transform: NO TRANSFORMATION

Summary Statistics on Data TABLE 1 of 2

GRP	IDENTIFICATION	N	MIN	MAX	MEAN
1	Control	4	5.8000	6.6000	6.1750
2	APG-02	4	15.3000	28.5000	19.5000
3	APG-06	4	11.3000	13.0000	12.0250
4	APG-16	4	7.3000	11.9000	10.1250
5	APG-15	4	6.9000	10.7000	9.0000

Title: 60147216-445-(035-038)
File: boron2.dat Transform: NO TRANSFORMATION

Summary Statistics on Data TABLE 2 of 2

GRP	IDENTIFICATION	VARIANCE	SD	SEM	C.V. %
1	Control	0.1225	0.3500	0.1750	5.6680
2	APG-02	36.7267	6.0603	3.0301	31.0782
3	APG-06	0.7425	0.8617	0.4308	7.1658
4	APG-16	4.4958	2.1203	1.0602	20.9416
5	APG-15	2.5667	1.6021	0.8010	17.8009

Toxstat Version 3.5
Study # 60147216-445-(035-038)
ESTCP
Echinochloa crusgalli
Analysis of Plant Nutrient: BORON using Lab Control

Page____of____

QA: CW 12/14/12
AK 12/14/12

Title: 60147216-445-(035-038)
File: boron2.dat Transform: LOG BASE 10(Y)

Shapiro - Wilk's Test for Normality

D = 0.0971
W = 0.9687

Critical W = 0.8680 (alpha = 0.01 , N = 20)
W = 0.9050 (alpha = 0.05 , N = 20)

Data PASS normality test (alpha = 0.01). Continue analysis.

Title: 60147216-445-(035-038)
File: boron2.dat Transform: LOG BASE 10(Y)

Bartlett's Test for Homogeneity of Variance

Calculated B1 statistic = 8.0980 (p-value = 0.0881)

Data PASS B1 homogeneity test at 0.01 level. Continue analysis.

Critical B = 13.2767 (alpha = 0.01, df = 4)
= 9.4877 (alpha = 0.05, df = 4)

Toxstat Version 3.5
Study # 60147216-445-(035-038)
ESTCP
Echinochloa crusgalli
Analysis of Plant Nutrient: BORON using Lab Control

QA: CW 12/14/12
12/14/12

Title: 60147216-445-(035-038)
File: boron2.dat   Transform: LOG BASE 10(Y)

ANOVA Table

SOURCE	DF	SS	MS	F
Between	4	0.5106	0.1277	19.7119
Within (Error)	15	0.0971	0.0065	
Total	19	0.6078		

(p-value = 0.0000)

Critical F = 4.8932 (alpha = 0.01, df = 4,15)
= 3.0556 (alpha = 0.05, df = 4,15)

Since F > Critical F REJECT Ho: All equal (alpha = 0.05)

Title: 60147216-445-(035-038)
File: boron2.dat   Transform: LOG BASE 10(Y)

Dunnett's Test - TABLE 1 OF 2   Ho:Control=Treatment

GROUP	IDENTIFICATION	TRANSFORMED MEAN	MEAN CALCULATED IN ORIGINAL UNITS	TRANS T STAT	SIG 0.05
1	Control	0.7901	6.1750		
2	APG-02	1.2764	19.5000	8.5453	*
3	APG-06	1.0793	12.0250	5.0811	*
4	APG-16	0.9975	10.1250	3.6449	*
5	APG-15	0.9487	9.0000	2.7877	*

Dunnett critical value = 2.7300 (2 Tailed, alpha = 0.05, df = 4,15)

Title: 60147216-445-(035-038)
File: boron2.dat   Transform: LOG BASE 10(Y)

Dunnett's Test - TABLE 2 OF 2   Ho:Control=Treatment

GROUP	IDENTIFICATION	NUM OF REPS	MIN SIG DIFF (IN ORIG. UNITS)	% OF CONTROL	DIFFERENCE FROM CONTROL
1	Control	4			
2	APG-02	4	1.8547	30.1	13.3250
3	APG-06	4	1.8547	30.1	5.8500
4	APG-16	4	1.8547	30.1	3.9500
5	APG-15	4	1.8547	30.1	2.8250

Toxstat Version 3.5 Page____of____
Study # 60147216-445-(035-038)
ESTCP
Echinochloa crusgalli
Summary Statistics for Plant Nutrient: CALCIUM (mg/kg) using Lab Control

QA: CW 12/14/12
12/14/12

Title: 60147216-445-(035-038)
File: calcium2.dat Transform: NO TRANSFORMATION

Summary Statistics on Data TABLE 1 of 2

GRP	IDENTIFICATION	N	MIN	MAX	MEAN
1	Control	4	16600.0000	23200.0000	19750.0000
2	APG-02	4	6770.0000	22400.0000	10912.5000
3	APG-06	4	9170.0000	24500.0000	13745.0000
4	APG-16	4	15800.0000	17300.0000	16575.0000
5	APG-15	4	21400.0000	44200.0000	32200.0000

Title: 60147216-445-(035-038)
File: calcium2.dat Transform: NO TRANSFORMATION

Summary Statistics on Data TABLE 2 of 2

GRP	IDENTIFICATION	VARIANCE	SD	SEM	C.V. %
1	Control	7316666.6667	2704.9338	1352.4669	13.6959
2	APG-02	58700225.0000	7661.6072	3830.8036	70.2095
3	APG-06	52932300.0000	7275.4587	3637.7294	52.9317
4	APG-16	482500.0000	694.6222	347.3111	4.1908
5	APG-15	129786666.6666	11392.3951	5696.1976	35.3801

Toxstat Version 3.5 Page____of____
Study # 60147216-445-(035-038)
ESTCP
Echinochloa crusgalli
Analysis of Plant Nutrient: CALCIUM using Lab Control

12/14/12
QA: CW 12/14/12

Title: 60147216-445-(035-038)
File: calcium2.dat Transform: SQUARE ROOT(Y)

Shapiro - Wilk's Test for Normality

D = 9053.8925
W = 0.9114

Critical W = 0.8680 (alpha = 0.01 , N = 20)
W = 0.9050 (alpha = 0.05 , N = 20)

Data PASS normality test (alpha = 0.01). Continue analysis.

Title: 60147216-445-(035-038)
File: calcium2.dat Transform: SQUARE ROOT(Y)

Bartlett's Test for Homogeneity of Variance

Calculated B1 statistic = 12.9265 (p-value = 0.0116)

Data PASS B1 homogeneity test at 0.01 level. Continue analysis.

Critical B = 13.2767 (alpha = 0.01, df = 4)
= 9.4877 (alpha = 0.05, df = 4)

Toxstat Version 3.5 Page____of____
Study # 60147216-445-(035-038)
ESTCP
Echinochloa crusgalli
Analysis of Plant Nutrient: CALCIUM using Lab Control

*12/14/12
QA: CW 12/14/12

Title: 60147216-445-(035-038)
File: calcium2.dat Transform: SQUARE ROOT(Y)

ANOVA Table

SOURCE	DF	SS	MS	F
Between	4	13692.7186	3423.1797	5.6713
Within (Error)	15	9053.8925	603.5928	
Total	19	22746.6111		

(p-value = 0.0055)

Critical F = 4.8932 (alpha = 0.01, df = 4,15)
= 3.0556 (alpha = 0.05, df = 4,15)

Since F > Critical F REJECT Ho: All equal (alpha = 0.05)

Title: 60147216-445-(035-038)
File: calcium2.dat Transform: SQUARE ROOT(Y)

Dunnett's Test - TABLE 1 OF 2 Ho:Control=Treatment

GROUP	IDENTIFICATION	TRANSFORMED MEAN	MEAN CALCULATED IN ORIGINAL UNITS	TRANS T STAT	SIG 0.05
1	Control	140.2882	19750.0000		
2	APG-02	100.5305	10912.5000	2.2886	
3	APG-06	114.5943	13745.0000	1.4790	
4	APG-16	128.7227	16575.0000	0.6657	
5	APG-15	177.2864	32200.0000	2.1297	

Dunnett critical value = 2.7300 (2 Tailed, alpha = 0.05, df = 4,15)

Title: 60147216-445-(035-038)
File: calcium2.dat Transform: SQUARE ROOT(Y)

Dunnett's Test - TABLE 2 OF 2 Ho:Control=Treatment

GROUP	IDENTIFICATION	NUM OF REPS	MIN SIG DIFF (IN ORIG. UNITS)	% OF CONTROL	DIFFERENCE FROM CONTROL
1	Control	4			
2	APG-02	4	999.9999	5.1	8837.5000
3	APG-06	4	999.9999	5.1	6005.0000
4	APG-16	4	999.9999	5.1	3175.0000
5	APG-15	4	999.9999	5.1	12450.0000

NOTE: MSD = 999.9999 means actual MSD estimate > 999.

Toxstat Version 3.5 Page____of____
Study # 60147216-445-(035-038)
ESTCP
Echinochloa crusgalli
Summary Statistics for Plant Nutrient: COPPER (mg/kg) using Lab Control

12/14/12
QA:cw 12/14/12

Title: 60147216-445-(035-038)
File: coppe.dat Transform: NO TRANSFORMATION

Summary Statistics on Data TABLE 1 of 2

GRP	IDENTIFICATION	N	MIN	MAX	MEAN
1	Control	4	1.8000	2.9000	2.2750
2	APG-02	4	13.2000	26.9000	20.6750
3	APG-06	4	5.3000	9.1000	7.0500
4	APG-16	4	8.5000	10.5000	9.5750
5	APG-15	4	11.4000	24.4000	15.5500

Title: 60147216-445-(035-038)
File: coppe.dat Transform: NO TRANSFORMATION

Summary Statistics on Data TABLE 2 of 2

GRP	IDENTIFICATION	VARIANCE	SD	SEM	C.V. %
1	Control	0.2358	0.4856	0.2428	21.3462
2	APG-02	47.8092	6.9144	3.4572	33.4434
3	APG-06	2.5433	1.5948	0.7974	22.6210
4	APG-16	0.9558	0.9777	0.4888	10.2106
5	APG-15	35.9567	5.9964	2.9982	38.5620

Toxstat Version 3.5 Page____of____
Study # 60147216-445-(035-038)
ESTCP
Echinochloa crusgalli
Analysis of Plant Nutrient: COPPER using Lab Control

12/14/12
12/14/12

Title: 60147216-445-(035-038)
File: coppe.dat Transform: LOG BASE 10(Y)

Shapiro - Wilk's Test for Normality

D = 0.1964
W = 0.9656

Critical W = 0.8680 (alpha = 0.01 , N = 20)
W = 0.9050 (alpha = 0.05 , N = 20)

Data PASS normality test (alpha = 0.01). Continue analysis.

Title: 60147216-445-(035-038)
File: coppe.dat Transform: LOG BASE 10(Y)

Bartlett's Test for Homogeneity of Variance

Calculated B1 statistic = 4.0710 (p-value = 0.3965)

Data PASS B1 homogeneity test at 0.01 level. Continue analysis.

Critical B = 13.2767 (alpha = 0.01, df = 4)
= 9.4877 (alpha = 0.05, df = 4)

Toxstat Version 3.5 Page____of____
Study # 60147216-445-(035-038)
ESTCP
Echinochloa crusgalli
Analysis of Plant Nutrient: COPPER using Lab Control

QA: cw 12/14/12
*12/14/12

Title: 60147216-445-(035-038)
File: coppe.dat Transform: LOG BASE 10(Y)

ANOVA Table

SOURCE	DF	SS	MS	F
Between	4	2.1566	0.5392	41.1698
Within (Error)	15	0.1964	0.0131	
Total	19	2.3531		

(p-value = 0.0000)

Critical F = 4.8932 (alpha = 0.01, df = 4,15)
= 3.0556 (alpha = 0.05, df = 4,15)

Since F > Critical F REJECT Ho: All equal (alpha = 0.05)

Title: 60147216-445-(035-038)
File: coppe.dat Transform: LOG BASE 10(Y)

Dunnett's Test - TABLE 1 OF 2 Ho:Control=Treatment

GROUP	IDENTIFICATION	TRANSFORMED MEAN	MEAN CALCULATED IN ORIGINAL UNITS	TRANS T STAT	SIG 0.05
1	Control	0.3497	2.2750		
2	APG-02	1.2959	20.6750	11.6923	*
3	APG-06	0.8399	7.0500	6.0574	*
4	APG-16	0.9794	9.5750	7.7817	*
5	APG-15	1.1710	15.5500	10.1487	*

Dunnett critical value = 2.7300 (2 Tailed, alpha = 0.05, df = 4,15)

Title: 60147216-445-(035-038)
File: coppe.dat Transform: LOG BASE 10(Y)

Dunnett's Test - TABLE 2 OF 2 Ho:Control=Treatment

GROUP	IDENTIFICATION	NUM OF REPS	MIN SIG DIFF (IN ORIG. UNITS)	% OF CONTROL	DIFFERENCE FROM CONTROL
1	Control	4			
2	APG-02	4	0.8920	39.9	18.4000
3	APG-06	4	0.8920	39.9	4.7750
4	APG-16	4	0.8920	39.9	7.3000
5	APG-15	4	0.8920	39.9	13.2750

Toxstat Version 3.5 Page____of____
Study # 60147216-445-(035-038)
ESTCP
Echinochloa crusgalli
Summary Statistics for Plant Nutrient: IRON (mg/kg) using Lab Control

dk 12/14/12
QA:CU 12/14/12

Title: 60147216-445-(035-038)
File: iron2.dat Transform: NO TRANSFORMATION

Summary Statistics on Data TABLE 1 of 2

GRP	IDENTIFICATION	N	MIN	MAX	MEAN
1	Control	4	41.8000	64.7000	51.8500
2	APG-02	4	91.3000	415.0000	250.0750
3	APG-06	4	121.0000	281.0000	173.2500
4	APG-16	4	53.5000	185.0000	108.7500
5	APG-15	4	61.7000	196.0000	114.9250

Title: 60147216-445-(035-038)
File: iron2.dat Transform: NO TRANSFORMATION

Summary Statistics on Data TABLE 2 of 2

GRP	IDENTIFICATION	VARIANCE	SD	SEM	C.V. %
1	Control	90.2167	9.4982	4.7491	18.3187
2	APG-02	24276.8892	155.8104	77.9052	62.3055
3	APG-06	5661.5833	75.2435	37.6217	43.4306
4	APG-16	3344.4167	57.8309	28.9155	53.1779
5	APG-15	3275.2892	57.2301	28.6151	49.7978

Toxstat Version 3.5 Page____of____
Study # 60147216-445-(035-038)
ESTCP
Echinochloa crusgalli
Analysis of Plant Nutrient: IRON using Lab Control

QA:CW 12/14/12
12/14/12

Title: 60147216-445-(035-038)
File: iron2.dat Transform: LOG BASE 10(Y)

Shapiro - Wilk's Test for Normality

D = 0.6909
W = 0.9570

Critical W = 0.8680 (alpha = 0.01 , N = 20)
W = 0.9050 (alpha = 0.05 , N = 20)

Data PASS normality test (alpha = 0.01). Continue analysis.

Title: 60147216-445-(035-038)
File: iron2.dat Transform: LOG BASE 10(Y)

Bartlett's Test for Homogeneity of Variance

Calculated B1 statistic = 4.3009 (p-value = 0.3668)

Data PASS B1 homogeneity test at 0.01 level. Continue analysis.

Critical B = 13.2767 (alpha = 0.01, df = 4)
= 9.4877 (alpha = 0.05, df = 4)

Toxstat Version 3.5 Page____of____
Study # 60147216-445-(035-038)
ESTCP
Echinochloa crusgalli
Analysis of Plant Nutrient: IRON using Lab Control

*12/14/12
QA: CW 12/14/12

Title: 60147216-445-(035-038)
File: iron2.dat Transform: LOG BASE 10(Y)

ANOVA Table

SOURCE	DF	SS	MS	F
Between	4	0.8798	0.2199	4.7750
Within (Error)	15	0.6909	0.0461	
Total	19	1.5707		

(p-value = 0.0110)

Critical F = 4.8932 (alpha = 0.01, df = 4,15)
= 3.0556 (alpha = 0.05, df = 4,15)

Since F > Critical F REJECT Ho: All equal (alpha = 0.05)

Title: 60147216-445-(035-038)
File: iron2.dat Transform: LOG BASE 10(Y)

Dunnett's Test - TABLE 1 OF 2 Ho:Control=Treatment

GROUP	IDENTIFICATION	TRANSFORMED MEAN	MEAN CALCULATED IN ORIGINAL UNITS	TRANS T STAT	SIG 0.05
1	Control	1.7094	51.8500		
2	APG-02	2.3211	250.0750	4.0306	*
3	APG-06	2.2114	173.2500	3.3079	*
4	APG-16	1.9896	108.7500	1.8461	
5	APG-15	2.0226	114.9250	2.0637	

Dunnett critical value = 2.7300 (2 Tailed, alpha = 0.05, df = 4,15)

Title: 60147216-445-(035-038)
File: iron2.dat Transform: LOG BASE 10(Y)

Dunnett's Test - TABLE 2 OF 2 Ho:Control=Treatment

GROUP	IDENTIFICATION	NUM OF REPS	MIN SIG DIFF (IN ORIG. UNITS)	% OF CONTROL	DIFFERENCE FROM CONTROL
1	Control	4			
2	APG-02	4	31.4892	61.5	198.2250
3	APG-06	4	31.4892	61.5	121.4000
4	APG-16	4	31.4892	61.5	56.9000
5	APG-15	4	31.4892	61.5	63.0750

Toxstat Version 3.5 Page___of____
Study # 60147216-445-(035-038)
ESTCP
Echinochloa crusgalli
Summary Statistics for Plant Nutrient: MAGNESIUM (mg/kg) using Lab Control

QA: cw 12/14/12
12/14/12

Title: 60147216-445-(035-038)3
File: magnesi.dat Transform: NO TRANSFORMATION

Summary Statistics on Data TABLE 1 of 2

GRP	IDENTIFICATION	N	MIN	MAX	MEAN
1	Control	4	10200.0000	12500.0000	10950.0000
2	APG-02	4	10700.0000	12900.0000	11900.0000
3	APG-06	4	11300.0000	14900.0000	13950.0000
4	APG-16	4	7870.0000	9380.0000	8417.5000
5	APG-15	4	9340.0000	10500.0000	10085.0000

Title: 60147216-445-(035-038)3
File: magnesi.dat Transform: NO TRANSFORMATION

Summary Statistics on Data TABLE 2 of 2

GRP	IDENTIFICATION	VARIANCE	SD	SEM	C.V. %
1	Control	1110000.0000	1053.5654	526.7827	9.6216
2	APG-02	1146666.6667	1070.8252	535.4126	8.9985
3	APG-06	3123333.3333	1767.2955	883.6477	12.6688
4	APG-16	456691.6667	675.7897	337.8948	8.0284
5	APG-15	275566.6667	524.9444	262.4722	5.2052

Toxstat Version 3.5 Page___of____
Study # 60147216-445-(035-038)
ESTCP
Echinochloa crusgalli
Analysis of Plant Nutrient: MAGNESIUM using Lab Control

QA:CW 12/14/12
[illegible] 12/14/12

Title: 60147216-445-(035-038)3
File: magnesi.dat Transform: NO TRANSFORMATION

Shapiro - Wilk's Test for Normality

D = 18336775.0000
W = 0.9329

Critical W = 0.8680 (alpha = 0.01 , N = 20)
W = 0.9050 (alpha = 0.05 , N = 20)

Data PASS normality test (alpha = 0.01). Continue analysis.

Title: 60147216-445-(035-038)3
File: magnesi.dat Transform: NO TRANSFORMATION

Bartlett's Test for Homogeneity of Variance

Calculated B1 statistic = 4.4916 (p-value = 0.3435)

Data PASS B1 homogeneity test at 0.01 level. Continue analysis.

Critical B = 13.2767 (alpha = 0.01, df = 4)
= 9.4877 (alpha = 0.05, df = 4)

Toxstat Version 3.5 Page___of____
Study # 60147216-445-(035-038)
ESTCP
Echinochloa crusgalli
Analysis of Plant Nutrient: MAGNESIUM using Lab Control

QA:CW 12/14/12
dB 12/14/12

Title: 60147216-445-(035-038)3
File: magnesi.dat Transform: NO TRANSFORMATION

ANOVA Table

SOURCE	DF	SS	MS	F
Between	4	68012920.0000	17003230.0000	13.9091
Within (Error)	15	18336775.0000	1222451.6667	
Total	19	86349695.0000		

(p-value = 0.0001)

Critical F = 4.8932 (alpha = 0.01, df = 4,15)
= 3.0556 (alpha = 0.05, df = 4,15)

Since F > Critical F REJECT Ho: All equal (alpha = 0.05)

Title: 60147216-445-(035-038)3
File: magnesi.dat Transform: NO TRANSFORMATION

Dunnett's Test - TABLE 1 OF 2 Ho:Control=Treatment

GROUP	IDENTIFICATION	TRANSFORMED MEAN	MEAN CALCULATED IN ORIGINAL UNITS	T STAT	SIG 0.05
1	Control	10950.0000	10950.0000		
2	APG-02	11900.0000	11900.0000	1.2151	
3	APG-06	13950.0000	13950.0000	3.8373	*
4	APG-16	8417.5000	8417.5000	3.2393	*
5	APG-15	10085.0000	10085.0000	1.1064	

Dunnett critical value = 2.7300 (2 Tailed, alpha = 0.05, df = 4,15)

Title: 60147216-445-(035-038)3
File: magnesi.dat Transform: NO TRANSFORMATION

Dunnett's Test - TABLE 2 OF 2 Ho:Control=Treatment

GROUP	IDENTIFICATION	NUM OF REPS	MIN SIG DIFF (IN ORIG. UNITS)	% OF CONTROL	DIFFERENCE FROM CONTROL
1	Control	4			
2	APG-02	4	999.9999	9.1	950.0000
3	APG-06	4	999.9999	9.1	3000.0000
4	APG-16	4	999.9999	9.1	2532.5000
5	APG-15	4	999.9999	9.1	865.0000

NOTE: MSD = 999.9999 means actual MSD estimate > 999.

Toxstat Version 3.5 Page___of____
Study # 60147216-445-(035-038)
ESTCP
Echinochloa crusgalli
Summary Statistics for Plant Nutrient: MANGANESE (mg/kg) using Lab Control

dk 12/14/12
QA: cw 12/14/12

Title: 60147216-445-(035-038)
File: mangane.dat Transform: NO TRANSFORMATION

Summary Statistics on Data TABLE 1 of 2

GRP	IDENTIFICATION	N	MIN	MAX	MEAN
1	Control	4	167.0000	263.0000	205.5000
2	APG-02	4	1160.0000	2370.0000	1742.5000
3	APG-06	4	181.0000	880.0000	440.7500
4	APG-16	4	245.0000	666.0000	512.2500
5	APG-15	4	342.0000	496.0000	424.0000

Title: 60147216-445-(035-038)
File: mangane.dat Transform: NO TRANSFORMATION

Summary Statistics on Data TABLE 2 of 2

GRP	IDENTIFICATION	VARIANCE	SD	SEM	C.V. %
1	Control	1689.0000	41.0974	20.5487	19.9988
2	APG-02	321758.3333	567.2375	283.6187	32.5531
3	APG-06	96024.2500	309.8778	154.9389	70.3069
4	APG-16	35434.9167	188.2416	94.1208	36.7480
5	APG-15	4028.6667	63.4718	31.7359	14.9698

Toxstat Version 3.5 Page___of____
Study # 60147216-445-(035-038)
ESTCP
Echinochloa crusgalli
Analysis of Plant Nutrient: MANGANESE using Lab Control

de 12/14/12
QA: ov 12/14/12

Title: 60147216-445-(035-038)
File: mangane.dat Transform: LOG BASE 10(Y)

Shapiro - Wilk's Test for Normality

D = 0.4749
W = 0.9631

Critical W = 0.8680 (alpha = 0.01 , N = 20)
W = 0.9050 (alpha = 0.05 , N = 20)

Data PASS normality test (alpha = 0.01). Continue analysis.

Title: 60147216-445-(035-038)
File: mangane.dat Transform: LOG BASE 10(Y)

Bartlett's Test for Homogeneity of Variance

Calculated B1 statistic = 7.0198 (p-value = 0.1348)

Data PASS B1 homogeneity test at 0.01 level. Continue analysis.

Critical B = 13.2767 (alpha = 0.01, df = 4)
= 9.4877 (alpha = 0.05, df = 4)

Toxstat Version 3.5 Page___of____
Study # 60147216-445-(035-038)
ESTCP
Echinochloa crusgalli
Analysis of Plant Nutrient: MANGANESE using Lab Control

QA:CW 12/14/12
12/14/12

Title: 60147216-445-(035-038)
File: mangane.dat Transform: LOG BASE 10(Y)

ANOVA Table

SOURCE	DF	SS	MS	F
Between	4	1.8009	0.4502	14.2214
Within (Error)	15	0.4749	0.0317	
Total	19	2.2758		

(p-value = 0.0001)

Critical F = 4.8932 (alpha = 0.01, df = 4,15)
= 3.0556 (alpha = 0.05, df = 4,15)

Since F > Critical F REJECT Ho: All equal (alpha = 0.05)

Title: 60147216-445-(035-038)
File: mangane.dat Transform: LOG BASE 10(Y)

Dunnett's Test - TABLE 1 OF 2 Ho:Control=Treatment

GROUP	IDENTIFICATION	TRANSFORMED MEAN	MEAN CALCULATED IN ORIGINAL UNITS	TRANS T STAT	SIG 0.05
1	Control	2.3067	205.5000		
2	APG-02	3.2232	1742.5000	7.2852	*
3	APG-06	2.5680	440.7500	2.0771	
4	APG-16	2.6799	512.2500	2.9667	*
5	APG-15	2.6236	424.0000	2.5189	

Dunnett critical value = 2.7300 (2 Tailed, alpha = 0.05, df = 4,15)

Title: 60147216-445-(035-038)
File: mangane.dat Transform: LOG BASE 10(Y)

Dunnett's Test - TABLE 2 OF 2 Ho:Control=Treatment

GROUP	IDENTIFICATION	NUM OF REPS	MIN SIG DIFF (IN ORIG. UNITS)	% OF CONTROL	DIFFERENCE FROM CONTROL
1	Control	4			
2	APG-02	4	110.7360	54.7	1537.0000
3	APG-06	4	110.7360	54.7	235.2500
4	APG-16	4	110.7360	54.7	306.7500
5	APG-15	4	110.7360	54.7	218.5000

Toxstat Version 3.5
Page___of____
Study # 60147216-445-(035-038)
ESTCP
Echinochloa crusgalli
Summary Statistics for Plant Nutrient: PHOSPHORUS (mg/kg) using Lab Control

QA: CW 12/14/12
12/14/12

Title: 60147216-445-(035-038)
File: phosph.dat Transform: NO TRANSFORMATION

Summary Statistics on Data TABLE 1 of 2

GRP	IDENTIFICATION	N	MIN	MAX	MEAN
1	Control	4	2440.0000	3160.0000	2875.0000
2	APG-02	4	1920.0000	2660.0000	2302.5000
3	APG-06	4	1930.0000	2360.0000	2090.0000
4	APG-16	4	1440.0000	2070.0000	1757.5000
5	APG-15	4	1730.0000	2090.0000	1915.0000

Title: 60147216-445-(035-038)
File: phosph.dat Transform: NO TRANSFORMATION

Summary Statistics on Data TABLE 2 of 2

GRP	IDENTIFICATION	VARIANCE	SD	SEM	C.V. %
1	Control	117966.6667	343.4628	171.7314	11.9465
2	APG-02	91491.6667	302.4759	151.2379	13.1368
3	APG-06	34866.6667	186.7262	93.3631	8.9343
4	APG-16	66758.3333	258.3763	129.1882	14.7014
5	APG-15	34700.0000	186.2794	93.1397	9.7274

Toxstat Version 3.5
Study # 60147216-445-(035-038)
ESTCP
Echinochloa crusgalli
Analysis of Plant Nutrient: PHOSPHORUS using Lab Control

Page___of____

de 12/14/12
QA: CW 12/14/12

Title: 60147216-445-(035-038)
File: phosph.dat Transform: NO TRANSFORMATION

Shapiro - Wilk's Test for Normality

D = 1037350.0000
W = 0.9582

Critical W = 0.8680 (alpha = 0.01 , N = 20)
W = 0.9050 (alpha = 0.05 , N = 20)

Data PASS normality test (alpha = 0.01). Continue analysis.

Title: 60147216-445-(035-038)
File: phosph.dat Transform: NO TRANSFORMATION

Bartlett's Test for Homogeneity of Variance

Calculated B1 statistic = 1.5773 (p-value = 0.8129)

Data PASS B1 homogeneity test at 0.01 level. Continue analysis.

Critical B = 13.2767 (alpha = 0.01, df = 4)
= 9.4877 (alpha = 0.05, df = 4)

Toxstat Version 3.5 Page___of____
Study # 60147216-445-(035-038)
ESTCP
Echinochloa crusgalli
Analysis of Plant Nutrient: PHOSPHORUS using Lab Control

12/14/12
QA: CW 12/14/12

Title: 60147216-445-(035-038)
File: phosph.dat Transform: NO TRANSFORMATION

ANOVA Table

SOURCE	DF	SS	MS	F
Between	4	3018170.0000	754542.5000	10.9106
Within (Error)	15	1037350.0000	69156.6667	
Total	19	4055520.0000		

(p-value = 0.0002)

Critical F = 4.8932 (alpha = 0.01, df = 4,15)
= 3.0556 (alpha = 0.05, df = 4,15)

Since F > Critical F REJECT Ho: All equal (alpha = 0.05)

Title: 60147216-445-(035-038)
File: phosph.dat Transform: NO TRANSFORMATION

Dunnett's Test - TABLE 1 OF 2 Ho:Control=Treatment

GROUP	IDENTIFICATION	TRANSFORMED MEAN	MEAN CALCULATED IN ORIGINAL UNITS	T STAT	SIG 0.05
1	Control	2875.0000	2875.0000		
2	APG-02	2302.5000	2302.5000	3.0787	*
3	APG-06	2090.0000	2090.0000	4.2215	*
4	APG-16	1757.5000	1757.5000	6.0096	*
5	APG-15	1915.0000	1915.0000	5.1626	*

Dunnett critical value = 2.7300 (2 Tailed, alpha = 0.05, df = 4,15)

Title: 60147216-445-(035-038)
File: phosph.dat Transform: NO TRANSFORMATION

Dunnett's Test - TABLE 2 OF 2 Ho:Control=Treatment

GROUP	IDENTIFICATION	NUM OF REPS	MIN SIG DIFF (IN ORIG. UNITS)	% OF CONTROL	DIFFERENCE FROM CONTROL
1	Control	4			
2	APG-02	4	507.6503	17.7	572.5000
3	APG-06	4	507.6503	17.7	785.0000
4	APG-16	4	507.6503	17.7	1117.5000
5	APG-15	4	507.6503	17.7	960.0000

Toxstat Version 3.5 Page____of____
Study # 60147216-445-(035-038)
ESTCP
Echinochloa crusgalli
Summary Statistics for Plant Nutrient: POTASSIUM (mg/kg) using Lab Control

*12/14/12
QA: W 12/14/12

Title: 60147216-445-(035-038)
File: potasiu.dat Transform: NO TRANSFORMATION

Summary Statistics on Data TABLE 1 of 2

GRP	IDENTIFICATION	N	MIN	MAX	MEAN
1	Control	4	14400.0000	18800.0000	15750.0000
2	APG-02	4	14900.0000	18300.0000	16650.0000
3	APG-06	4	16500.0000	19900.0000	17975.0000
4	APG-16	4	12700.0000	18900.0000	16225.0000
5	APG-15	4	14300.0000	18300.0000	16725.0000

Title: 60147216-445-(035-038)
File: potasiu.dat Transform: NO TRANSFORMATION

Summary Statistics on Data TABLE 2 of 2

GRP	IDENTIFICATION	VARIANCE	SD	SEM	C.V. %
1	Control	4216666.6667	2053.4524	1026.7262	13.0378
2	APG-02	2170000.0000	1473.0920	736.5460	8.8474
3	APG-06	3035833.3333	1742.3643	871.1821	9.6933
4	APG-16	9449166.6667	3073.9497	1536.9748	18.9458
5	APG-15	3389166.6667	1840.9689	920.4845	11.0073

Toxstat Version 3.5
Study # 60147216-445-(035-038)
ESTCP
Echinochloa crusgalli
Analysis of Plant Nutrient: POTASSIUM using Lab Control

Page____of____

QA:CW 12/14/12
JR 12/14/12

Title: 60147216-445-(035-038)
File: potasiu.dat Transform: NO TRANSFORMATION

Shapiro - Wilk's Test for Normality

D = 66782500.0000
W = 0.9530

Critical W = 0.8680 (alpha = 0.01 , N = 20)
W = 0.9050 (alpha = 0.05 , N = 20)

Data PASS normality test (alpha = 0.01). Continue analysis.

Title: 60147216-445-(035-038)
File: potasiu.dat Transform: NO TRANSFORMATION

Bartlett's Test for Homogeneity of Variance

Calculated B1 statistic = 1.7899 (p-value = 0.7743)

Data PASS B1 homogeneity test at 0.01 level. Continue analysis.

Critical B = 13.2767 (alpha = 0.01, df = 4)
= 9.4877 (alpha = 0.05, df = 4)

Toxstat Version 3.5
Study # 60147216-445-(035-038)
ESTCP
Echinochloa crusgalli
Analysis of Plant Nutrient: POTASSIUM using Lab Control

Page____of____

ON:CW 12/14/12
AB 12/14/12

Title: 60147216-445-(035-038)
File: potasiu.dat Transform: NO TRANSFORMATION

ANOVA Table

SOURCE	DF	SS	MS	F
Between	4	11003000.0000	2750750.0000	0.6178
Within (Error)	15	66782500.0000	4452166.6667	
Total	19	77785500.0000		

(p-value = 0.6566)

Critical F = 4.8932 (alpha = 0.01, df = 4,15)
= 3.0556 (alpha = 0.05, df = 4,15)

Since F < Critical F FAIL TO REJECT Ho: All equal (alpha = 0.05)

Title: 60147216-445-(035-038)
File: potasiu.dat Transform: NO TRANSFORMATION

Dunnett's Test - TABLE 1 OF 2 Ho:Control=Treatment

GROUP	IDENTIFICATION	TRANSFORMED MEAN	MEAN CALCULATED IN ORIGINAL UNITS	T STAT	SIG 0.05
1	Control	15750.0000	15750.0000		
2	APG-02	16650.0000	16650.0000	0.6032	
3	APG-06	17975.0000	17975.0000	1.4913	
4	APG-16	16225.0000	16225.0000	0.3184	
5	APG-15	16725.0000	16725.0000	0.6535	

Dunnett critical value = 2.7300 (2 Tailed, alpha = 0.05, df = 4,15)

Title: 60147216-445-(035-038)
File: potasiu.dat Transform: NO TRANSFORMATION

Dunnett's Test - TABLE 2 OF 2 Ho:Control=Treatment

GROUP	IDENTIFICATION	NUM OF REPS	MIN SIG DIFF (IN ORIG. UNITS)	% OF CONTROL	DIFFERENCE FROM CONTROL
1	Control	4			
2	APG-02	4	999.9999	6.3	900.0000
3	APG-06	4	999.9999	6.3	2225.0000
4	APG-16	4	999.9999	6.3	475.0000
5	APG-15	4	999.9999	6.3	975.0000

NOTE: MSD = 999.9999 means actual MSD estimate > 999.

Toxstat Version 3.5 Page____of____
Study # 60147216-445-(035-038)
ESTCP
Echinochloa crusgalli
Summary Statistics for Plant Nutrient: SODIUM (mg/kg) using Lab Control

12/14/12
QA: CW 12/14/12

Title: 60147216-445-(035-038)
File: sodium.dat Transform: NO TRANSFORMATION

Summary Statistics on Data TABLE 1 of 2

GRP	IDENTIFICATION	N	MIN	MAX	MEAN
1	Control	4	84.4000	124.0000	99.1250
2	APG-02	4	946.0000	6260.0000	2579.0000
3	APG_06	4	727.0000	4000.0000	2304.2500
4	APG-16	4	3700.0000	5810.0000	5050.0000
5	APG-15	4	3490.0000	11200.0000	6175.0000

Title: 60147216-445-(035-038)
File: sodium.dat Transform: NO TRANSFORMATION

Summary Statistics on Data TABLE 2 of 2

GRP	IDENTIFICATION	VARIANCE	SD	SEM	C.V. %
1	Control	315.5025	17.7624	8.8812	17.9192
2	APG-02	6170684.0000	2484.0861	1242.0431	96.3197
3	APG_06	1995452.2500	1412.6048	706.3024	61.3043
4	APG-16	878466.6667	937.2655	468.6328	18.5597
5	APG-15	12001366.6667	3464.2989	1732.1494	56.1020

Toxstat Version 3.5
Study # 60147216-445-(035-038)
ESTCP
Echinochloa crusgalli
Analysis of Plant Nutrient: SODIUM using Lab Control

Page____of____

12/14/12
QA. CW 12/14/12

Title: 60147216-445-(035-038)
File: sodium.dat Transform: LOG BASE 10(Y)

Shapiro - Wilk's Test for Normality

D = 0.8879
W = 0.9700

Critical W = 0.8680 (alpha = 0.01 , N = 20)
W = 0.9050 (alpha = 0.05 , N = 20)

Data PASS normality test (alpha = 0.01). Continue analysis.

Title: 60147216-445-(035-038)
File: sodium.dat Transform: LOG BASE 10(Y)

Bartlett's Test for Homogeneity of Variance

Calculated B1 statistic = 8.6048 (p-value = 0.0718)

Data PASS B1 homogeneity test at 0.01 level. Continue analysis.

Critical B = 13.2767 (alpha = 0.01, df = 4)
= 9.4877 (alpha = 0.05, df = 4)

Toxstat Version 3.5
Study # 60147216-445-(035-038)
ESTCP
Echinochloa crusgalli
Analysis of Plant Nutrient: SODIUM using Lab Control

dk 12/14/12
QA: CW 12/14/12

Title: 60147216-445-(035-038)
File: sodium.dat Transform: LOG BASE 10(Y)

ANOVA Table

SOURCE	DF	SS	MS	F
Between	4	8.0815	2.0204	34.1308
Within (Error)	15	0.8879	0.0592	
Total	19	8.9695		

(p-value = 0.0000)

Critical F = 4.8932 (alpha = 0.01, df = 4,15)
= 3.0556 (alpha = 0.05, df = 4,15)

Since F > Critical F REJECT Ho: All equal (alpha = 0.05)

Title: 60147216-445-(035-038)
File: sodium.dat Transform: LOG BASE 10(Y)

Dunnett's Test - TABLE 1 OF 2 Ho:Control=Treatment

GROUP	IDENTIFICATION	TRANSFORMED MEAN	MEAN CALCULATED IN ORIGINAL UNITS	TRANS T STAT	SIG 0.05
1	Control	1.9913	99.1250		
2	APG-02	3.2844	2579.0000	7.5167	*
3	APG_06	3.2847	2304.2500	7.5181	*
4	APG-16	3.6970	5050.0000	9.9146	*
5	APG-15	3.7460	6175.0000	10.1994	*

Dunnett critical value = 2.7300 (2 Tailed, alpha = 0.05, df = 4,15)

Title: 60147216-445-(035-038)
File: sodium.dat Transform: LOG BASE 10(Y)

Dunnett's Test - TABLE 2 OF 2 Ho:Control=Treatment

GROUP	IDENTIFICATION	NUM OF REPS	MIN SIG DIFF (IN ORIG. UNITS)	% OF CONTROL	DIFFERENCE FROM CONTROL
1	Control	4			
2	APG-02	4	64.7722	66.1	2479.8750
3	APG_06	4	64.7722	66.1	2205.1250
4	APG-16	4	64.7722	66.1	4950.8750
5	APG-15	4	64.7722	66.1	6075.8750

Toxstat Version 3.5 Page____of____
Study # 60147216-445-(035-038)
ESTCP
Echinochloa crusgalli
Summary Statistics for Plant Nutrient: SULFUR (mg/kg) using Lab Control

QA:CW 12/14/12
12/14/12

Title: 60147216-445-(035-038)
File: sulfu.dat Transform: NO TRANSFORMATION

Summary Statistics on Data TABLE 1 of 2

GRP	IDENTIFICATION	N	MIN	MAX	MEAN
1	Control	4	3440.0000	5070.0000	4247.5000
2	APG-02	4	13200.0000	32400.0000	19000.0000
3	APG-06	4	15600.0000	28900.0000	20875.0000
4	APG-16	4	18200.0000	19800.0000	19025.0000
5	APG-15	4	23600.0000	42900.0000	32125.0000

Title: 60147216-445-(035-038)
File: sulfu.dat Transform: NO TRANSFORMATION

Summary Statistics on Data TABLE 2 of 2

GRP	IDENTIFICATION	VARIANCE	SD	SEM	C.V. %
1	Control	529291.6667	727.5243	363.7622	17.1283
2	APG-02	81653333.3334	9036.2234	4518.1117	47.5591
3	APG-06	32009166.6667	5657.6644	2828.8322	27.1026
4	APG-16	509166.6667	713.5592	356.7796	3.7506
5	APG-15	86195833.3334	9284.1711	4642.0856	28.9001

Toxstat Version 3.5 Page____of____
Study # 60147216-445-(035-038)
ESTCP
Echinochloa crusgalli
Analysis of Plant Nutrient: SULFUR using Lab Control

an:cw 12/14/12
ck 12/14/12

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Title:  60147216-445-(035-038)
File:        sulfu.dat           Transform:              LOG BASE 10(Y)

                 Shapiro - Wilk's Test for Normality
---------------------------------------------------------------------------

     D =    0.1992
     W =    0.9248

     Critical W  = 0.8680 (alpha = 0.01 , N = 20)
              W  = 0.9050 (alpha = 0.05 , N = 20)

---------------------------------------------------------------------------
Data PASS normality test (alpha = 0.01). Continue analysis.


Title:  60147216-445-(035-038)
File:        sulfu.dat           Transform:              LOG BASE 10(Y)

              Bartlett's Test for Homogeneity of Variance
---------------------------------------------------------------------------

Calculated B1 statistic =   9.9743              (p-value = 0.0409)

Data PASS B1 homogeneity test at 0.01 level. Continue analysis.

---------------------------------------------------------------------------

Critical B = 13.2767  (alpha = 0.01, df =  4)
           =  9.4877  (alpha = 0.05, df =  4)
```

Toxstat Version 3.5
Study # 60147216-445-(035-038)
ESTCP
Echinochloa crusgalli
Analysis of Plant Nutrient: SULFUR using Lab Control

Page____of____

QA:CW 12/14/12
12/14/12

Title: 60147216-445-(035-038)
File: sulfu.dat Transform: LOG BASE 10(Y)

ANOVA Table

SOURCE	DF	SS	MS	F
Between	4	1.7537	0.4384	33.0158
Within (Error)	15	0.1992	0.0133	
Total	19	1.9528		

(p-value = 0.0000)

Critical F = 4.8932 (alpha = 0.01, df = 4,15)
= 3.0556 (alpha = 0.05, df = 4,15)

Since F > Critical F REJECT Ho: All equal (alpha = 0.05)

Title: 60147216-445-(035-038)
File: sulfu.dat Transform: LOG BASE 10(Y)

Dunnett's Test - TABLE 1 OF 2 Ho:Control=Treatment

GROUP	IDENTIFICATION	TRANSFORMED MEAN	MEAN CALCULATED IN ORIGINAL UNITS	TRANS T STAT	SIG 0.05
1	Control	3.6233	4247.5000		
2	APG-02	4.2480	19000.0000	7.6670	*
3	APG-06	4.3085	20875.0000	8.4095	*
4	APG-16	4.2791	19025.0000	8.0484	*
5	APG-15	4.4932	32125.0000	10.6754	*

Dunnett critical value = 2.7300 (2 Tailed, alpha = 0.05, df = 4,15)

Title: 60147216-445-(035-038)
File: sulfu.dat Transform: LOG BASE 10(Y)

Dunnett's Test - TABLE 2 OF 2 Ho:Control=Treatment

GROUP	IDENTIFICATION	NUM OF REPS	MIN SIG DIFF (IN ORIG. UNITS)	% OF CONTROL	DIFFERENCE FROM CONTROL
1	Control	4			
2	APG-02	4	999.9999	23.8	14752.5000
3	APG-06	4	999.9999	23.8	16627.5000
4	APG-16	4	999.9999	23.8	14777.5000
5	APG-15	4	999.9999	23.8	27877.5000

NOTE: MSD = 999.9999 means actual MSD estimate > 999.

Toxstat Version 3.5
Study # 60147216-445-(035-038)
ESTCP
Echinochloa crusgalli
Summary Statistics for Plant Nutrient: ZINC (mg/kg) using Lab Control

QA:CW 12/14/12
12/14/12

Title: 60147216-445-(035-038)
File: zinc2.dat Transform: NO TRANSFORMATION

Summary Statistics on Data TABLE 1 of 2

GRP	IDENTIFICATION	N	MIN	MAX	MEAN
1	Control	4	25.0000	38.7000	33.0000
2	APG-02	4	345.0000	1870.0000	771.2500
3	APG-06	4	162.0000	392.0000	300.7500
4	APG-16	4	448.0000	1200.0000	872.7500
5	APG-15	4	287.0000	809.0000	600.2500

Title: 60147216-445-(035-038)
File: zinc2.dat Transform: NO TRANSFORMATION

Summary Statistics on Data TABLE 2 of 2

GRP	IDENTIFICATION	VARIANCE	SD	SEM	C.V. %
1	Control	33.1800	5.7602	2.8801	17.4552
2	APG-02	538356.9167	733.7281	366.8640	95.1349
3	APG-06	9570.2500	97.8277	48.9138	32.5279
4	APG-16	99623.5833	315.6320	157.8160	36.1652
5	APG-15	59058.2500	243.0190	121.5095	40.4863

Toxstat Version 3.5
Study # 60147216-445-(035-038)
ESTCP
Echinochloa crusgalli
Analysis of Plant Nutrient: ZINC using Lab Control

Page____of____

*12/14/12
QA: CW 12/14/12

Title: 60147216-445-(035-038)
File: zinc2.dat   Transform: LOG BASE 10(Y)

Shapiro - Wilk's Test for Normality

D = 0.6787
W = 0.9288

Critical W = 0.8680 (alpha = 0.01 , N = 20)
W = 0.9050 (alpha = 0.05 , N = 20)

Data PASS normality test (alpha = 0.01). Continue analysis.

Title: 60147216-445-(035-038)
File: zinc2.dat   Transform: LOG BASE 10(Y)

Bartlett's Test for Homogeneity of Variance

Calculated B1 statistic = 4.7389   (p-value = 0.3152)

Data PASS B1 homogeneity test at 0.01 level. Continue analysis.

Critical B = 13.2767 (alpha = 0.01, df = 4)
= 9.4877 (alpha = 0.05, df = 4)

Toxstat Version 3.5 Page____of____
Study # 60147216-445-(035-038)
ESTCP
Echinochloa crusgalli
Analysis of Plant Nutrient: ZINC using Lab Control

aptcw 12/14/12
dk 12/14/12

Title: 60147216-445-(035-038)
File: zinc2.dat Transform: LOG BASE 10(Y)

ANOVA Table

SOURCE	DF	SS	MS	F
Between	4	5.1177	1.2794	28.2764
Within (Error)	15	0.6787	0.0452	
Total	19	5.7964		

(p-value = 0.0000)

Critical F = 4.8932 (alpha = 0.01, df = 4,15)
= 3.0556 (alpha = 0.05, df = 4,15)

Since F > Critical F REJECT Ho: All equal (alpha = 0.05)

Title: 60147216-445-(035-038)
File: zinc2.dat Transform: LOG BASE 10(Y)

Dunnett's Test - TABLE 1 OF 2 Ho:Control=Treatment

GROUP	IDENTIFICATION	TRANSFORMED MEAN	MEAN CALCULATED IN ORIGINAL UNITS	TRANS T STAT	SIG 0.05
1	Control	1.5131	33.0000		
2	APG-02	2.7717	771.2500	8.3675	*
3	APG-06	2.4563	300.7500	6.2709	*
4	APG-16	2.9144	872.7500	9.3168	*
5	APG-15	2.7449	600.2500	8.1893	*

Dunnett critical value = 2.7300 (2 Tailed, alpha = 0.05, df = 4,15)

Title: 60147216-445-(035-038)
File: zinc2.dat Transform: LOG BASE 10(Y)

Dunnett's Test - TABLE 2 OF 2 Ho:Control=Treatment

GROUP	IDENTIFICATION	NUM OF REPS	MIN SIG DIFF (IN ORIG. UNITS)	% OF CONTROL	DIFFERENCE FROM CONTROL
1	Control	4			
2	APG-02	4	19.9294	61.2	738.2500
3	APG-06	4	19.9294	61.2	267.7500
4	APG-16	4	19.9294	61.2	839.7500
5	APG-15	4	19.9294	61.2	567.2500

Toxstat Version 3.5 Page____of____
Study # 60147216-445-(035-038)
ESTCP
Echinochloa crusgalli
Summary Statistics for Plant Nutrient: NITROGEN using Lab Control

QA:CW 12/14/12
12/14/12

Title: 60147216-445-(035-038)
File: nitrog.dat Transform: NO TRANSFORMATION

Summary Statistics on Data TABLE 1 of 2

GRP	IDENTIFICATION	N	MIN	MAX	MEAN
1	Control	4	0.8300	1.0500	0.9325
2	APG-02	4	0.8100	0.9700	0.8775
3	APG-06	4	0.7500	0.8200	0.7850
4	APG-16	4	0.6900	0.8100	0.7650
5	APG-15	4	0.6700	0.7700	0.7300

Title: 60147216-445-(035-038)
File: nitrog.dat Transform: NO TRANSFORMATION

Summary Statistics on Data TABLE 2 of 2

GRP	IDENTIFICATION	VARIANCE	SD	SEM	C.V. %
1	Control	0.0082	0.0903	0.0452	9.6862
2	APG-02	0.0053	0.0727	0.0364	8.2899
3	APG-06	0.0008	0.0289	0.0144	3.6774
4	APG-16	0.0028	0.0526	0.0263	6.8757
5	APG-15	0.0018	0.0424	0.0212	5.8118

Toxstat Version 3.5
Study # 60147216-445-(035-038)
ESTCP
Echinochloa crusgalli
Analysis of Plant Nutrient: NITROGEN using Lab Control

Page____of____

QA:CW 12/14/12
CR 12/14/12

```
Title:  60147216-445-(035-038)
File:        nitrog.dat               Transform:              NO TRANSFORMATION

                    Shapiro - Wilk's Test for Normality
-----------------------------------------------------------------------------

     D =   0.0566
     W =   0.9740

     Critical W  = 0.8680 (alpha = 0.01 , N = 20)
              W  = 0.9050 (alpha = 0.05 , N = 20)

-----------------------------------------------------------------------------

Data PASS normality test (alpha = 0.01). Continue analysis.


Title:  60147216-445-(035-038)
File:        nitrog.dat               Transform:              NO TRANSFORMATION

                 Bartlett's Test for Homogeneity of Variance
-----------------------------------------------------------------------------

Calculated B1 statistic =  3.8305              (p-value = 0.4294)

Data PASS B1 homogeneity test at 0.01 level. Continue analysis.

-----------------------------------------------------------------------------

Critical B = 13.2767  (alpha = 0.01, df =  4)
           =  9.4877  (alpha = 0.05, df =  4)
```

Toxstat Version 3.5
Study # 60147216-445-(035-038)
ESTCP
Echinochloa crusgalli
Analysis of Plant Nutrient: NITROGEN using Lab Control

QA: CW 12/14/12
12/14/12

Title: 60147216-445-(035-038)
File: nitrog.dat Transform: NO TRANSFORMATION

ANOVA Table

SOURCE	DF	SS	MS	F
Between	4	0.1132	0.0283	7.5046
Within (Error)	15	0.0566	0.0038	
Total	19	0.1697		

(p-value = 0.0016)

Critical F = 4.8932 (alpha = 0.01, df = 4,15)
= 3.0556 (alpha = 0.05, df = 4,15)

Since F > Critical F REJECT Ho: All equal (alpha = 0.05)

Title: 60147216-445-(035-038)
File: nitrog.dat Transform: NO TRANSFORMATION

Dunnett's Test - TABLE 1 OF 2 Ho:Control=Treatment

GROUP	IDENTIFICATION	TRANSFORMED MEAN	MEAN CALCULATED IN ORIGINAL UNITS	T STAT	SIG 0.05
1	Control	0.9325	0.9325		
2	APG-02	0.8775	0.8775	1.2668	
3	APG-06	0.7850	0.7850	3.3973	*
4	APG-16	0.7650	0.7650	3.8580	*
5	APG-15	0.7300	0.7300	4.6641	*

Dunnett critical value = 2.7300 (2 Tailed, alpha = 0.05, df = 4,15)

Title: 60147216-445-(035-038)
File: nitrog.dat Transform: NO TRANSFORMATION

Dunnett's Test - TABLE 2 OF 2 Ho:Control=Treatment

GROUP	IDENTIFICATION	NUM OF REPS	MIN SIG DIFF (IN ORIG. UNITS)	% OF CONTROL	DIFFERENCE FROM CONTROL
1	Control	4			
2	APG-02	4	0.1185	12.7	0.0550
3	APG-06	4	0.1185	12.7	0.1475
4	APG-16	4	0.1185	12.7	0.1675
5	APG-15	4	0.1185	12.7	0.2025

Toxstat Version 3.5 Page____of____
Study # 60147216-445-(035-038)
ESTCP
Echinochloa crusgalli
Summary Statistics for Plant Nutrient: BORON (mg/kg) using Site Control

QA: CW 12/14/12
12/14/12

Title: 60147216-445-(035-038)
File: boron1.dat Transform: NO TRANSFORMATION

Summary Statistics on Data TABLE 1 of 2

GRP	IDENTIFICATION	N	MIN	MAX	MEAN
1	APG-15	4	6.9000	10.7000	9.0000
2	APG-02	4	15.3000	28.5000	19.5000
3	APG-06	4	11.3000	13.0000	12.0250
4	APG-16	4	7.3000	11.9000	10.1250

Title: 60147216-445-(035-038)
File: boron1.dat Transform: NO TRANSFORMATION

Summary Statistics on Data TABLE 2 of 2

GRP	IDENTIFICATION	VARIANCE	SD	SEM	C.V. %
1	APG-15	2.5667	1.6021	0.8010	17.8009
2	APG-02	36.7267	6.0603	3.0301	31.0782
3	APG-06	0.7425	0.8617	0.4308	7.1658
4	APG-16	4.4958	2.1203	1.0602	20.9416

Toxstat Version 3.5 Page____of____
Study # 60147216-445-(035-038)
ESTCP
Echinochloa crusgalli
Analysis of Plant Nutrient: BORON (mg/kg) using Site Control

AP 12/14/12
QA: CU 12/14/12

Title: 60147216-445-(035-038)
File: boron1.dat Transform: NO TRANSFORMATION

Shapiro - Wilk's Test for Normality

D = 133.5950
W = 0.8461

Critical W = 0.8440 (alpha = 0.01 , N = 16)
W = 0.8870 (alpha = 0.05 , N = 16)

Data PASS normality test (alpha = 0.01). Continue analysis.

Title: 60147216-445-(035-038)
File: boron1.dat Transform: NO TRANSFORMATION

Bartlett's Test for Homogeneity of Variance

Calculated B1 statistic = 10.2418 (p-value = 0.0166)

Data PASS B1 homogeneity test at 0.01 level. Continue analysis.

Critical B = 11.3449 (alpha = 0.01, df = 3)
= 7.8147 (alpha = 0.05, df = 3)

Study # 60147216-445-(035-038)
ESTCP
Echinochloa crusgalli
Analysis of Plant Nutrient: BORON (mg/kg) using Site Control

dk 12/14/12
QA: cw 12/14/12

Title: 60147216-445-(035-038)
File: boron1.dat Transform: NO TRANSFORMATION

ANOVA Table

SOURCE	DF	SS	MS	F
Between	3	268.0425	89.3475	8.0255
Within (Error)	12	133.5950	11.1329	
Total	15	401.6375		

(p-value = 0.0034)

Critical F = 5.9525 (alpha = 0.01, df = 3,12)
= 3.4903 (alpha = 0.05, df = 3,12)

Since F > Critical F REJECT Ho: All equal (alpha = 0.05)

Title: 60147216-445-(035-038)
File: boron1.dat Transform: NO TRANSFORMATION

Dunnett's Test - TABLE 1 OF 2 Ho:Control=Treatment

GROUP	IDENTIFICATION	TRANSFORMED MEAN	MEAN CALCULATED IN ORIGINAL UNITS	T STAT	SIG 0.05
1	APG-15	9.0000	9.0000		
2	APG-02	19.5000	19.5000	4.4504	*
3	APG-06	12.0250	12.0250	1.2821	
4	APG-16	10.1250	10.1250	0.4768	

Dunnett critical value = 2.6800 (2 Tailed, alpha = 0.05, df = 3,12)

Title: 60147216-445-(035-038)
File: boron1.dat Transform: NO TRANSFORMATION

Dunnett's Test - TABLE 2 OF 2 Ho:Control=Treatment

GROUP	IDENTIFICATION	NUM OF REPS	MIN SIG DIFF (IN ORIG. UNITS)	% OF CONTROL	DIFFERENCE FROM CONTROL
1	APG-15	4			
2	APG-02	4	6.3230	70.3	10.5000
3	APG-06	4	6.3230	70.3	3.0250
4	APG-16	4	6.3230	70.3	1.1250

Toxstat Version 3.5
Study # 60147216-445-(035-038)
ESTCP
Echinochloa crusgalli
Summary Statistics for Plant Nutrient: CALCIUM (mg/kg) using Site Control

12/14/12
QA:CW 12/14/12

Title: 60147216-445-(035-038)
File: calcium.dat Transform: NO TRANSFORMATION

Summary Statistics on Data TABLE 1 of 2

GRP	IDENTIFICATION	N	MIN	MAX	MEAN
1	APG-15	4	21400.0000	44200.0000	32200.0000
2	APG-02	4	6770.0000	22400.0000	10912.5000
3	APG-06	4	9170.0000	24500.0000	13745.0000
4	APG-16	4	15800.0000	17300.0000	16575.0000

Title: 60147216-445-(035-038)
File: calcium.dat Transform: NO TRANSFORMATION

Summary Statistics on Data TABLE 2 of 2

GRP	IDENTIFICATION	VARIANCE	SD	SEM	C.V. %
1	APG-15	129786666.6666	11392.3951	5696.1976	35.3801
2	APG-02	58700225.0000	7661.6072	3830.8036	70.2095
3	APG-06	52932300.0000	7275.4587	3637.7294	52.9317
4	APG-16	482500.0000	694.6222	347.3111	4.1908

```
Toxstat Version 3.5                                              Page____of_____
Study # 60147216-445-(035-038)
ESTCP
Echinochloa crusgalli
Analysis of Plant Nutrient: CALCIUM using Site Control           ck 12/14/12
                                                                 QA:cw 12/14/12
  Title:  60147216-445-(035-038)
  File:       calcium.dat              Transform:              NO TRANSFORMATION

                  Shapiro - Wilk's Test for Normality
  ----------------------------------------------------------------------------

      D = 725705075.0000
      W =    0.9038

      Critical W  = 0.8440 (alpha = 0.01 , N = 16)
               W  = 0.8870 (alpha = 0.05 , N = 16)

  ----------------------------------------------------------------------------

  Data PASS normality test (alpha = 0.01). Continue analysis.


  Title:  60147216-445-(035-038)
  File:       calcium.dat              Transform:              NO TRANSFORMATION

               Bartlett's Test for Homogeneity of Variance
  ----------------------------------------------------------------------------

  Calculated B1 statistic = 11.1434               (p-value = 0.0110)

  Data PASS B1 homogeneity test at 0.01 level. Continue analysis.

  ----------------------------------------------------------------------------

  Critical B = 11.3449  (alpha = 0.01, df =  3)
             =  7.8147  (alpha = 0.05, df =  3)
```

Toxstat Version 3.5
Study # 60147216-445-(035-038)
ESTCP
Echinochloa crusgalli
Analysis of Plant Nutrient: CALCIUM using Site Control

Page____of_____

dk 12/14/12
QA: cw 12/14/12

Title: 60147216-445-(035-038)
File: calcium.dat Transform: NO TRANSFORMATION

ANOVA Table

SOURCE	DF	SS	MS	F
Between	3	1085981168.7500	361993722.9165	5.9858
Within (Error)	12	725705075.0000	60475422.9167	
Total	15	1811686243.7500		

(p-value = 0.0098)

Critical F = 5.9525 (alpha = 0.01, df = 3,12)
= 3.4903 (alpha = 0.05, df = 3,12)

Since F > Critical F REJECT Ho: All equal (alpha = 0.05)

Title: 60147216-445-(035-038)
File: calcium.dat Transform: NO TRANSFORMATION

Dunnett's Test - TABLE 1 OF 2 Ho:Control=Treatment

GROUP	IDENTIFICATION	TRANSFORMED MEAN	MEAN CALCULATED IN ORIGINAL UNITS	T STAT	SIG 0.05
1	APG-15	32200.0000	32200.0000		
2	APG-02	10912.5000	10912.5000	3.8712	*
3	APG-06	13745.0000	13745.0000	3.3561	*
4	APG-16	16575.0000	16575.0000	2.8415	*

Dunnett critical value = 2.6800 (2 Tailed, alpha = 0.05, df = 3,12)

Title: 60147216-445-(035-038)
File: calcium.dat Transform: NO TRANSFORMATION

Dunnett's Test - TABLE 2 OF 2 Ho:Control=Treatment

GROUP	IDENTIFICATION	NUM OF REPS	MIN SIG DIFF (IN ORIG. UNITS)	% OF CONTROL	DIFFERENCE FROM CONTROL
1	APG-15	4			
2	APG-02	4	999.9999	3.1	21287.5000
3	APG-06	4	999.9999	3.1	18455.0000
4	APG-16	4	999.9999	3.1	15625.0000

NOTE: MSD = 999.9999 means actual MSD estimate > 999.

Toxstat Version 3.5 Page____of_____
Study # 60147216-445-(035-038)
ESTCP
Echinochloa crusgalli
Summary Statistics for Plant Nutrient: COPPER (mg/kg) using Site Control

dk 12/14/12
QA: 12/14/12

Title: 60147216-445-(035-038)
File: copper.dat Transform: NO TRANSFORMATION

Summary Statistics on Data TABLE 1 of 2

GRP	IDENTIFICATION	N	MIN	MAX	MEAN
1	APG-15	4	11.4000	24.4000	15.5500
2	APG-02	4	13.2000	26.9000	20.6750
3	APG-06	4	5.3000	9.1000	7.0500
4	APG-16	4	8.5000	10.5000	9.5750

Title: 60147216-445-(035-038)
File: copper.dat Transform: NO TRANSFORMATION

Summary Statistics on Data TABLE 2 of 2

GRP	IDENTIFICATION	VARIANCE	SD	SEM	C.V. %
1	APG-15	35.9567	5.9964	2.9982	38.5620
2	APG-02	47.8092	6.9144	3.4572	33.4434
3	APG-06	2.5433	1.5948	0.7974	22.6210
4	APG-16	0.9558	0.9777	0.4888	10.2106

Toxstat Version 3.5 Page____of_____
Study # 60147216-445-(035-038)
ESTCP
Echinochloa crusgalli
Analysis of Plant Nutrient: COPPER using Site Control

d8 12/14/12
QA: cw 12/14/12

```
  Title:  60147216-445-(035-038)
  File:         copper.dat             Transform:            NO TRANSFORMATION

                     Shapiro - Wilk's Test for Normality
  ---------------------------------------------------------------------------

       D = 261.7950
       W =   0.9597

       Critical W  = 0.8440 (alpha = 0.01 , N = 16)
                W  = 0.8870 (alpha = 0.05 , N = 16)

  ---------------------------------------------------------------------------

  Data PASS normality test (alpha = 0.01). Continue analysis.


  Title:  60147216-445-(035-038)
  File:         copper.dat             Transform:            NO TRANSFORMATION

                  Bartlett's Test for Homogeneity of Variance
  ---------------------------------------------------------------------------

  Calculated B1 statistic = 10.5176             (p-value = 0.0146)

  Data PASS B1 homogeneity test at 0.01 level. Continue analysis.

  ---------------------------------------------------------------------------

  Critical B = 11.3449  (alpha = 0.01, df =  3)
             =  7.8147  (alpha = 0.05, df =  3)
```

Toxstat Version 3.5 Page____of_____
Study # 60147216-445-(035-038)
ESTCP
Echinochloa crusgalli
Analysis of Plant Nutrient: COPPER using Site Control

*12/14/12
QA:CW 12/14/12

Title: 60147216-445-(035-038)
File: copper.dat Transform: NO TRANSFORMATION

ANOVA Table

SOURCE	DF	SS	MS	F
Between	3	449.4425	149.8142	6.8671
Within (Error)	12	261.7950	21.8162	
Total	15	711.2375		

(p-value = 0.0060)

Critical F = 5.9525 (alpha = 0.01, df = 3,12)
= 3.4903 (alpha = 0.05, df = 3,12)

Since F > Critical F REJECT Ho: All equal (alpha = 0.05)

Title: 60147216-445-(035-038)
File: copper.dat Transform: NO TRANSFORMATION

Dunnett's Test - TABLE 1 OF 2 Ho:Control=Treatment

GROUP	IDENTIFICATION	TRANSFORMED MEAN	MEAN CALCULATED IN ORIGINAL UNITS	T STAT	SIG 0.05
1	APG-15	15.5500	15.5500		
2	APG-02	20.6750	20.6750	1.5517	
3	APG-06	7.0500	7.0500	2.5736	
4	APG-16	9.5750	9.5750	1.8091	

Dunnett critical value = 2.6800 (2 Tailed, alpha = 0.05, df = 3,12)

Title: 60147216-445-(035-038)
File: copper.dat Transform: NO TRANSFORMATION

Dunnett's Test - TABLE 2 OF 2 Ho:Control=Treatment

GROUP	IDENTIFICATION	NUM OF REPS	MIN SIG DIFF (IN ORIG. UNITS)	% OF CONTROL	DIFFERENCE FROM CONTROL
1	APG-15	4			
2	APG-02	4	8.8514	56.9	5.1250
3	APG-06	4	8.8514	56.9	8.5000
4	APG-16	4	8.8514	56.9	5.9750

Toxstat Version 3.5 Page____of____
Study # 60147216-445-(035-038)
ESTCP
Echinochloa crusgalli
① ~~Sumamry~~ Summary Statistics for Plant Nutrient: IRON (mg/kg) using Site Control

✱ 12/14/12
QA: CW 12/14/12

Title: 60147216-445-(035-038)
File: iron.dat Transform: NO TRANSFORMATION

Summary Statistics on Data TABLE 1 of 2

GRP	IDENTIFICATION	N	MIN	MAX	MEAN
1	APG-15	4	61.7000	196.0000	114.9250
2	APG-02	4	91.3000	415.0000	250.0750
3	APG-06	4	121.0000	281.0000	173.2500
4	APG-16	4	53.5000	185.0000	108.7500

Title: 60147216-445-(035-038)
File: iron.dat Transform: NO TRANSFORMATION

Summary Statistics on Data TABLE 2 of 2

GRP	IDENTIFICATION	VARIANCE	SD	SEM	C.V. %
1	APG-15	3275.2892	57.2301	28.6151	49.7978
2	APG-02	24276.8892	155.8104	77.9052	62.3055
3	APG-06	5661.5833	75.2435	37.6217	43.4306
4	APG-16	3344.4167	57.8309	28.9155	53.1779

① CW for ANP 12/14/12 E

Toxstat Version 3.5
Study # 60147216-445-(035-038)
ESTCP
Echinochloa crusgalli
Analysis of Plant Nutrient: IRON using Site Control

Page____of____

*12/14/12
QA: cw 12/14/12

Title: 60147216-445-(035-038)
File: iron.dat   Transform: NO TRANSFORMATION

Shapiro - Wilk's Test for Normality

D = 109674.5350
W = 0.9613

Critical W = 0.8440 (alpha = 0.01 , N = 16)
W = 0.8870 (alpha = 0.05 , N = 16)

Data PASS normality test (alpha = 0.01). Continue analysis.

Title: 60147216-445-(035-038)
File: iron.dat   Transform: NO TRANSFORMATION

Bartlett's Test for Homogeneity of Variance

Calculated B1 statistic = 4.0395   (p-value = 0.2572)

Data PASS B1 homogeneity test at 0.01 level. Continue analysis.

Critical B = 11.3449 (alpha = 0.01, df = 3)
= 7.8147 (alpha = 0.05, df = 3)

Toxstat Version 3.5 Page____of____
Study # 60147216-445-(035-038)
ESTCP
Echinochloa crusgalli
Analysis of Plant Nutrient: IRON using Site Control

12/14/12
QA: CW 12/14/12

Title: 60147216-445-(035-038)
File: iron.dat Transform: NO TRANSFORMATION

ANOVA Table

SOURCE	DF	SS	MS	F
Between	3	51740.5450	17246.8483	1.8871
Within (Error)	12	109674.5350	9139.5446	
Total	15	161415.0800		

(p-value = 0.1856)

Critical F = 5.9525 (alpha = 0.01, df = 3,12)
= 3.4903 (alpha = 0.05, df = 3,12)

Since F < Critical F FAIL TO REJECT Ho: All equal (alpha = 0.05)

Title: 60147216-445-(035-038)
File: iron.dat Transform: NO TRANSFORMATION

Dunnett's Test - TABLE 1 OF 2 Ho:Control=Treatment

GROUP	IDENTIFICATION	TRANSFORMED MEAN	MEAN CALCULATED IN ORIGINAL UNITS	T STAT	SIG 0.05
1	APG-15	114.9250	114.9250		
2	APG-02	250.0750	250.0750	1.9993	
3	APG-06	173.2500	173.2500	0.8628	
4	APG-16	108.7500	108.7500	0.0913	

Dunnett critical value = 2.6800 (2 Tailed, alpha = 0.05, df = 3,12)

Title: 60147216-445-(035-038)
File: iron.dat Transform: NO TRANSFORMATION

Dunnett's Test - TABLE 2 OF 2 Ho:Control=Treatment

GROUP	IDENTIFICATION	NUM OF REPS	MIN SIG DIFF (IN ORIG. UNITS)	% OF CONTROL	DIFFERENCE FROM CONTROL
1	APG-15	4			
2	APG-02	4	181.1682	157.6	135.1500
3	APG-06	4	181.1682	157.6	58.3250
4	APG-16	4	181.1682	157.6	6.1750

Toxstat Version 3.5 Page____of____
Study # 60147216-445-(035-038)
ESTCP
Echinochloa crusgalli
Summary Statistics for Plant Nutrient: MAGNESIUM (mg/kg) using Site Control

12/14/12
QA: CW 12/14/12

Title: 60147216-445-(035-038)
File: magnes.dat Transform: NO TRANSFORMATION

Summary Statistics on Data TABLE 1 of 2

GRP	IDENTIFICATION	N	MIN	MAX	MEAN
1	APG-15	4	9340.0000	10500.0000	10085.0000
2	APG-02	4	10700.0000	12900.0000	11900.0000
3	APG-06	4	11300.0000	14900.0000	13950.0000
4	APG-16	4	7870.0000	9380.0000	8417.5000

Title: 60147216-445-(035-038)
File: magnes.dat Transform: NO TRANSFORMATION

Summary Statistics on Data TABLE 2 of 2

GRP	IDENTIFICATION	VARIANCE	SD	SEM	C.V. %
1	APG-15	275566.6667	524.9444	262.4722	5.2052
2	APG-02	1146666.6667	1070.8252	535.4126	8.9985
3	APG-06	3123333.3333	1767.2955	883.6477	12.6688
4	APG-16	456691.6667	675.7897	337.8948	8.0284

Toxstat Version 3.5 Page____of____
Study # 60147216-445-(035-038)
ESTCP
Echinochloa crusgalli
Analysis of Plant Nutrient: MAGNESIUM using Site Control

dk 12/14/12
QA: cw 12/14/12

Title: 60147216-445-(035-038)
File: magnes.dat Transform: NO TRANSFORMATION

Shapiro - Wilk's Test for Normality

D = 15006775.0000
W = 0.8726

Critical W = 0.8440 (alpha = 0.01 , N = 16)
W = 0.8870 (alpha = 0.05 , N = 16)

Data PASS normality test (alpha = 0.01). Continue analysis.

Title: 60147216-445-(035-038)
File: magnes.dat Transform: NO TRANSFORMATION

Bartlett's Test for Homogeneity of Variance

Calculated B1 statistic = 4.4551 (p-value = 0.2163)

Data PASS B1 homogeneity test at 0.01 level. Continue analysis.

Critical B = 11.3449 (alpha = 0.01, df = 3)
= 7.8147 (alpha = 0.05, df = 3)

Toxstat Version 3.5 Page____of____
Study # 60147216-445-(035-038)
ESTCP
Echinochloa crusgalli
Analysis of Plant Nutrient: MAGNESIUM using Site Control

*12/14/12
QA:CO 12/14/12

Title: 60147216-445-(035-038)
File: magnes.dat Transform: NO TRANSFORMATION

ANOVA Table

SOURCE	DF	SS	MS	F
Between	3	67951868.7500	22650622.9167	18.1123
Within (Error)	12	15006775.0000	1250564.5833	
Total	15	82958643.7500		

(p-value = 0.0001)

Critical F = 5.9525 (alpha = 0.01, df = 3,12)
= 3.4903 (alpha = 0.05, df = 3,12)

Since F > Critical F REJECT Ho: All equal (alpha = 0.05)

Title: 60147216-445-(035-038)
File: magnes.dat Transform: NO TRANSFORMATION

Dunnett's Test - TABLE 1 OF 2 Ho:Control=Treatment

GROUP	IDENTIFICATION	TRANSFORMED MEAN	MEAN CALCULATED IN ORIGINAL UNITS	T STAT	SIG 0.05
1	APG-15	10085.0000	10085.0000		
2	APG-02	11900.0000	11900.0000	2.2953	
3	APG-06	13950.0000	13950.0000	4.8878	*
4	APG-16	8417.5000	8417.5000	2.1088	

Dunnett critical value = 2.6800 (2 Tailed, alpha = 0.05, df = 3,12)

Title: 60147216-445-(035-038)
File: magnes.dat Transform: NO TRANSFORMATION

Dunnett's Test - TABLE 2 OF 2 Ho:Control=Treatment

GROUP	IDENTIFICATION	NUM OF REPS	MIN SIG DIFF (IN ORIG. UNITS)	% OF CONTROL	DIFFERENCE FROM CONTROL
1	APG-15	4			
2	APG-02	4	999.9999	9.9	1815.0000
3	APG-06	4	999.9999	9.9	3865.0000
4	APG-16	4	999.9999	9.9	1667.5000

NOTE: MSD = 999.9999 means actual MSD estimate > 999.

Toxstat Version 3.5
Study # 60147216-445-(035-038)
ESTCP
Echinochloa crusgalli
Summary Statistics for Plant Nutrient: MANGANSESE (mg/kg) using Site Control

Page____of_____

12/14/12
QA: CW 12/14/12

Title: 60147216-445-(035-038)
File: mangan.dat Transform: NO TRANSFORMATION

Summary Statistics on Data TABLE 1 of 2

GRP	IDENTIFICATION	N	MIN	MAX	MEAN
1	APG-15	4	342.0000	496.0000	424.0000
2	APG-02	4	1160.0000	2370.0000	1742.5000
3	APG-06	4	181.0000	880.0000	440.7500
4	APG-16	4	245.0000	666.0000	512.2500

Title: 60147216-445-(035-038)
File: mangan.dat Transform: NO TRANSFORMATION

Summary Statistics on Data TABLE 2 of 2

GRP	IDENTIFICATION	VARIANCE	SD	SEM	C.V. %
1	APG-15	4028.6667	63.4718	31.7359	14.9698
2	APG-02	321758.3333	567.2375	283.6187	32.5531
3	APG-06	96024.2500	309.8778	154.9389	70.3069
4	APG-16	35434.9167	188.2416	94.1208	36.7480

① CW 12/14/12 E

Toxstat Version 3.5 Page_____of_____
Study # 60147216-445-(035-038)
ESTCP
Echinochloa crusgalli
Analysis of Plant Nutrient: MANGANSESE using Site Control

K 12/14/12
GA:CW 12/14/12

Title: 60147216-445-(035-038)
File: mangan.dat Transform: NO TRANSFORMATION

Shapiro - Wilk's Test for Normality

D = 1371738.5000
W = 0.9804

Critical W = 0.8440 (alpha = 0.01 , N = 16)
W = 0.8870 (alpha = 0.05 , N = 16)

Data PASS normality test (alpha = 0.01). Continue analysis.

Title: 60147216-445-(035-038)
File: mangan.dat Transform: NO TRANSFORMATION

Bartlett's Test for Homogeneity of Variance

Calculated B1 statistic = 9.6309 (p-value = 0.0220)

Data PASS B1 homogeneity test at 0.01 level. Continue analysis.

Critical B = 11.3449 (alpha = 0.01, df = 3)
= 7.8147 (alpha = 0.05, df = 3)

Toxstat Version 3.5 Page____of_____
Study # 60147216-445-(035-038)
ESTCP
Echinochloa crusgalli
Analysis of Plant Nutrient: MANGANSESE using Site Control

AK 12/14/12
QA: CW 12/14/12

Title: 60147216-445-(035-038)
File: mangan.dat Transform: NO TRANSFORMATION

ANOVA Table

SOURCE	DF	SS	MS	F
Between	3	4959691.2500	1653230.4167	14.4625
Within (Error)	12	1371738.5000	114311.5417	
Total	15	6331429.7500		

(p-value = 0.0003)

Critical F = 5.9525 (alpha = 0.01, df = 3,12)
= 3.4903 (alpha = 0.05, df = 3,12)

Since F > Critical F REJECT Ho: All equal (alpha = 0.05)

Title: 60147216-445-(035-038)
File: mangan.dat Transform: NO TRANSFORMATION

Dunnett's Test - TABLE 1 OF 2 Ho:Control=Treatment

GROUP	IDENTIFICATION	TRANSFORMED MEAN	MEAN CALCULATED IN ORIGINAL UNITS	T STAT	SIG 0.05
1	APG-15	424.0000	424.0000		
2	APG-02	1742.5000	1742.5000	5.5151	*
3	APG-06	440.7500	440.7500	0.0701	
4	APG-16	512.2500	512.2500	0.3691	

Dunnett critical value = 2.6800 (2 Tailed, alpha = 0.05, df = 3,12)

Title: 60147216-445-(035-038)
File: mangan.dat Transform: NO TRANSFORMATION

Dunnett's Test - TABLE 2 OF 2 Ho:Control=Treatment

GROUP	IDENTIFICATION	NUM OF REPS	MIN SIG DIFF (IN ORIG. UNITS)	% OF CONTROL	DIFFERENCE FROM CONTROL
1	APG-15	4			
2	APG-02	4	640.7149	151.1	1318.5000
3	APG-06	4	640.7149	151.1	16.7500
4	APG-16	4	640.7149	151.1	88.2500

Toxstat Version 3.5 Page____of_____
Study # 60147216-445-(035-038)
ESTCP
Echinochloa crusgalli
Summary Statistics for Plant Nutrient: PHOSPHORUS (mg/kg) using Site Control

*12/14/12
QA: CU 12/14/12

Title: 60147216-445-(035-038)
File: phosp.dat Transform: NO TRANSFORMATION

Summary Statistics on Data TABLE 1 of 2

GRP	IDENTIFICATION	N	MIN	MAX	MEAN
1	APG-15	4	1730.0000	2090.0000	1915.0000
2	APG-02	4	1920.0000	2660.0000	2302.5000
3	APG-06	4	1930.0000	2360.0000	2090.0000
4	APG-16	4	1440.0000	2070.0000	1757.5000

Title: 60147216-445-(035-038)
File: phosp.dat Transform: NO TRANSFORMATION

Summary Statistics on Data TABLE 2 of 2

GRP	IDENTIFICATION	VARIANCE	SD	SEM	C.V. %
1	APG-15	34700.0000	186.2794	93.1397	9.7274
2	APG-02	91491.6667	302.4759	151.2379	13.1368
3	APG-06	34866.6667	186.7262	93.3631	8.9343
4	APG-16	66758.3333	258.3763	129.1882	14.7014

Toxstat Version 3.5 Page____of_____
Study # 60147216-445-(035-038)
ESTCP
Echinochloa crusgalli
Analysis of Plant Nutrient: PHOSPHORUS using Site Control

K12/14/12
QA: CW 12/14/12

```
  Title:  60147216-445-(035-038)
  File:          phosp.dat              Transform:              NO TRANSFORMATION

                     Shapiro - Wilk's Test for Normality
  ----------------------------------------------------------------------------

       D = 683450.0000
       W =    0.9732

       Critical W  = 0.8440 (alpha = 0.01 , N = 16)
                W  = 0.8870 (alpha = 0.05 , N = 16)

  ----------------------------------------------------------------------------
  Data PASS normality test (alpha = 0.01). Continue analysis.


  Title:  60147216-445-(035-038)
  File:          phosp.dat              Transform:              NO TRANSFORMATION

                  Bartlett's Test for Homogeneity of Variance
  ----------------------------------------------------------------------------

  Calculated B1 statistic =  0.9309              (p-value = 0.8180)

  Data PASS B1 homogeneity test at 0.01 level. Continue analysis.
  ----------------------------------------------------------------------------

  Critical B = 11.3449  (alpha = 0.01, df =  3)
             =  7.8147  (alpha = 0.05, df =  3)
```

Toxstat Version 3.5 Page____of_____
Study # 60147216-445-(035-038)
ESTCP
Echinochloa crusgalli
Analysis of Plant Nutrient: PHOSPHORUS using Site Control

*12/14/12
QA: cv 12/14/12

Title: 60147216-445-(035-038)
File: phosp.dat Transform: NO TRANSFORMATION

ANOVA Table

SOURCE	DF	SS	MS	F
Between	3	658325.0000	219441.6667	3.8530
Within (Error)	12	683450.0000	56954.1667	
Total	15	1341775.0000		

(p-value = 0.0384)

Critical F = 5.9525 (alpha = 0.01, df = 3,12)
= 3.4903 (alpha = 0.05, df = 3,12)

Since F > Critical F REJECT Ho: All equal (alpha = 0.05)

Title: 60147216-445-(035-038)
File: phosp.dat Transform: NO TRANSFORMATION

Dunnett's Test - TABLE 1 OF 2 Ho:Control=Treatment

GROUP	IDENTIFICATION	TRANSFORMED MEAN	MEAN CALCULATED IN ORIGINAL UNITS	T STAT	SIG 0.05
1	APG-15	1915.0000	1915.0000		
2	APG-02	2302.5000	2302.5000	2.2963	
3	APG-06	2090.0000	2090.0000	1.0370	
4	APG-16	1757.5000	1757.5000	0.9333	

Dunnett critical value = 2.6800 (2 Tailed, alpha = 0.05, df = 3,12)

Title: 60147216-445-(035-038)
File: phosp.dat Transform: NO TRANSFORMATION

Dunnett's Test - TABLE 2 OF 2 Ho:Control=Treatment

GROUP	IDENTIFICATION	NUM OF REPS	MIN SIG DIFF (IN ORIG. UNITS)	% OF CONTROL	DIFFERENCE FROM CONTROL
1	APG-15	4			
2	APG-02	4	452.2541	23.6	387.5000
3	APG-06	4	452.2541	23.6	175.0000
4	APG-16	4	452.2541	23.6	157.5000

Toxstat Version 3.5 Page____of____
Study # 60147216-445-(035-038)
ESTCP
Echinochloa crusgalli
Summary Statistics for Plant Nutrient: POTASSIUM (mg/kg) using Site Control

dk 12/14/12
QA: a 12/14/12

Title: 60147216-445-(035-038)
File: potasi.dat Transform: NO TRANSFORMATION

Summary Statistics on Data TABLE 1 of 2

GRP	IDENTIFICATION	N	MIN	MAX	MEAN
1	APG-15	4	14300.0000	18300.0000	16725.0000
2	APG-02	4	14900.0000	18300.0000	16650.0000
3	APG-06	4	16500.0000	19900.0000	17975.0000
4	APG-16	4	12700.0000	18900.0000	16225.0000

Title: 60147216-445-(035-038)
File: potasi.dat Transform: NO TRANSFORMATION

Summary Statistics on Data TABLE 2 of 2

GRP	IDENTIFICATION	VARIANCE	SD	SEM	C.V. %
1	APG-15	3389166.6667	1840.9689	920.4845	11.0073
2	APG-02	2170000.0000	1473.0920	736.5460	8.8474
3	APG-06	3035833.3333	1742.3643	871.1821	9.6933
4	APG-16	9449166.6667	3073.9497	1536.9748	18.9458

Toxstat Version 3.5 Page____of____
Study # 60147216-445-(035-038)
ESTCP
Echinochloa crusgalli
Analysis of Plant Nutrient: POTASSIUM using Site Control

QA: CW 12/14/12
12/14/12

Title: 60147216-445-(035-038)
File: potasi.dat Transform: NO TRANSFORMATION

Shapiro - Wilk's Test for Normality

D = 54132500.0000
W = 0.9419

Critical W = 0.8440 (alpha = 0.01 , N = 16)
W = 0.8870 (alpha = 0.05 , N = 16)

Data PASS normality test (alpha = 0.01). Continue analysis.

Title: 60147216-445-(035-038)
File: potasi.dat Transform: NO TRANSFORMATION

Bartlett's Test for Homogeneity of Variance

Calculated B1 statistic = 1.7764 (p-value = 0.6201)

Data PASS B1 homogeneity test at 0.01 level. Continue analysis.

Critical B = 11.3449 (alpha = 0.01, df = 3)
= 7.8147 (alpha = 0.05, df = 3)

Toxstat Version 3.5 Page____of____
Study # 60147216-445-(035-038)
ESTCP
Echinochloa crusgalli
Analysis of Plant Nutrient: POTASSIUM using Site Control

QA:CW 12/14/12
dk 12/14/12

Title: 60147216-445-(035-038)
File: potasi.dat Transform: NO TRANSFORMATION

ANOVA Table

SOURCE	DF	SS	MS	F
Between	3	6816875.0000	2272291.6667	0.5037
Within (Error)	12	54132500.0000	4511041.6667	
Total	15	60949375.0000		

(p-value = 0.6869)

Critical F = 5.9525 (alpha = 0.01, df = 3,12)
= 3.4903 (alpha = 0.05, df = 3,12)

Since F < Critical F FAIL TO REJECT Ho: All equal (alpha = 0.05)

Title: 60147216-445-(035-038)
File: potasi.dat Transform: NO TRANSFORMATION

Dunnett's Test - TABLE 1 OF 2 Ho:Control=Treatment

GROUP	IDENTIFICATION	TRANSFORMED MEAN	MEAN CALCULATED IN ORIGINAL UNITS	T STAT	SIG 0.05
1	APG-15	16725.0000	16725.0000		
2	APG-02	16650.0000	16650.0000	0.0499	
3	APG-06	17975.0000	17975.0000	0.8323	
4	APG-16	16225.0000	16225.0000	0.3329	

Dunnett critical value = 2.6800 (2 Tailed, alpha = 0.05, df = 3,12)

Title: 60147216-445-(035-038)
File: potasi.dat Transform: NO TRANSFORMATION

Dunnett's Test - TABLE 2 OF 2 Ho:Control=Treatment

GROUP	IDENTIFICATION	NUM OF REPS	MIN SIG DIFF (IN ORIG. UNITS)	% OF CONTROL	DIFFERENCE FROM CONTROL
1	APG-15	4			
2	APG-02	4	999.9999	6.0	75.0000
3	APG-06	4	999.9999	6.0	1250.0000
4	APG-16	4	999.9999	6.0	500.0000

NOTE: MSD = 999.9999 means actual MSD estimate > 999.

Toxstat Version 3.5 Page____of____
Study # 60147216-445-(035-038)
ESTCP
Echinochloa crusgalli
Summary Statistics for Plant Nutrient: SODIUM (mg/kg) using Site Control

QA: CW 12/14/12
12/14/12

Title: 60147216-445-(035-038)
File: sodiu.dat Transform: NO TRANSFORMATION

Summary Statistics on Data TABLE 1 of 2

GRP	IDENTIFICATION	N	MIN	MAX	MEAN
1	APG-15	4	3490.0000	11200.0000	6175.0000
2	APG-02	4	946.0000	6260.0000	2579.0000
3	APG_06	4	727.0000	4000.0000	2304.2500
4	APG-16	4	3700.0000	5810.0000	5050.0000

Title: 60147216-445-(035-038)
File: sodiu.dat Transform: NO TRANSFORMATION

Summary Statistics on Data TABLE 2 of 2

GRP	IDENTIFICATION	VARIANCE	SD	SEM	C.V. %
1	APG-15	12001366.6667	3464.2989	1732.1494	56.1020
2	APG-02	6170684.0000	2484.0861	1242.0431	96.3197
3	APG_06	1995452.2500	1412.6048	706.3024	61.3043
4	APG-16	878466.6667	937.2655	468.6328	18.5597

Toxstat Version 3.5 Page____of____
Study # 60147216-445-(035-038)
ESTCP
Echinochloa crusgalli
Analysis of Plant Nutrient: SODIUM using Site Control

*12/14/12
QA: CU 12/14/12

Title: 60147216-445-(035-038)
File: sodiu.dat Transform: NO TRANSFORMATION

Shapiro - Wilk's Test for Normality

D = 63137908.7500
W = 0.8897

Critical W = 0.8440 (alpha = 0.01 , N = 16)
W = 0.8870 (alpha = 0.05 , N = 16)

Data PASS normality test (alpha = 0.01). Continue analysis.

Title: 60147216-445-(035-038)
File: sodiu.dat Transform: NO TRANSFORMATION

Bartlett's Test for Homogeneity of Variance

Calculated B1 statistic = 4.6770 (p-value = 0.1970)

Data PASS B1 homogeneity test at 0.01 level. Continue analysis.

Critical B = 11.3449 (alpha = 0.01, df = 3)
= 7.8147 (alpha = 0.05, df = 3)

Toxstat Version 3.5 Page____of____
Study # 60147216-445-(035-038)
ESTCP
Echinochloa crusgalli
Analysis of Plant Nutrient: SODIUM using Site Control

dk 12/14/12
QA: [illegible] 12/14/12

Title: 60147216-445-(035-038)
File: sodiu.dat Transform: NO TRANSFORMATION

ANOVA Table

SOURCE	DF	SS	MS	F
Between	3	42900018.1875	14300006.0625	2.7179
Within (Error)	12	63137908.7500	5261492.3958	
Total	15	106037926.9375		

(p-value = 0.0912)

Critical F = 5.9525 (alpha = 0.01, df = 3,12)
= 3.4903 (alpha = 0.05, df = 3,12)

Since F < Critical F FAIL TO REJECT Ho: All equal (alpha = 0.05)

Title: 60147216-445-(035-038)
File: sodiu.dat Transform: NO TRANSFORMATION

Dunnett's Test - TABLE 1 OF 2 Ho:Control=Treatment

GROUP	IDENTIFICATION	TRANSFORMED MEAN	MEAN CALCULATED IN ORIGINAL UNITS	T STAT	SIG 0.05
1	APG-15	6175.0000	6175.0000		
2	APG-02	2579.0000	2579.0000	2.2171	
3	APG_06	2304.2500	2304.2500	2.3865	
4	APG-16	5050.0000	5050.0000	0.6936	

Dunnett critical value = 2.6800 (2 Tailed, alpha = 0.05, df = 3,12)

Title: 60147216-445-(035-038)
File: sodiu.dat Transform: NO TRANSFORMATION

Dunnett's Test - TABLE 2 OF 2 Ho:Control=Treatment

GROUP	IDENTIFICATION	NUM OF REPS	MIN SIG DIFF (IN ORIG. UNITS)	% OF CONTROL	DIFFERENCE FROM CONTROL
1	APG-15	4			
2	APG-02	4	999.9999	16.2	3596.0000
3	APG_06	4	999.9999	16.2	3870.7500
4	APG-16	4	999.9999	16.2	1125.0000

NOTE: MSD = 999.9999 means actual MSD estimate > 999.

Toxstat Version 3.5 Page____of____
Study # 60147216-445-(035-038)
ESTCP
Echinochloa crusgalli
Summary Statistics for Plant Nutrient: SULFUR (mg/kg) using Site Control

12/14/12
QA: cu 12/14/12

Title: 60147216-445-(035-038)
File: sulf.dat Transform: NO TRANSFORMATION

Summary Statistics on Data TABLE 1 of 2

GRP	IDENTIFICATION	N	MIN	MAX	MEAN
1	APG-15	4	23600.0000	42900.0000	32125.0000
2	APG-02	4	13200.0000	32400.0000	19000.0000
3	APG-06	4	15600.0000	28900.0000	20875.0000
4	APG-16	4	18200.0000	19800.0000	19025.0000

Title: 60147216-445-(035-038)
File: sulf.dat Transform: NO TRANSFORMATION

Summary Statistics on Data TABLE 2 of 2

GRP	IDENTIFICATION	VARIANCE	SD	SEM	C.V. %
1	APG-15	86195833.3334	9284.1711	4642.0856	28.9001
2	APG-02	81653333.3334	9036.2234	4518.1117	47.5591
3	APG-06	32009166.6667	5657.6644	2828.8322	27.1026
4	APG-16	509166.6667	713.5592	356.7796	3.7506

Toxstat Version 3.5 Page____of____
Study # 60147216-445-(035-038)
ESTCP
Echinochloa crusgalli
Analysis of Plant Nutrient: SULFUR using Site Control

dk 12/14/12
QA: CU 12/14/12

Title: 60147216-445-(035-038)
File: sulf.dat Transform: NO TRANSFORMATION

Shapiro - Wilk's Test for Normality

D = 601102500.0000
W = 0.9215

Critical W = 0.8440 (alpha = 0.01 , N = 16)
W = 0.8870 (alpha = 0.05 , N = 16)

Data PASS normality test (alpha = 0.01). Continue analysis.

Title: 60147216-445-(035-038)
File: sulf.dat Transform: NO TRANSFORMATION

Bartlett's Test for Homogeneity of Variance

Calculated B1 statistic = 10.5505 (p-value = 0.0144)

Data PASS B1 homogeneity test at 0.01 level. Continue analysis.

Critical B = 11.3449 (alpha = 0.01, df = 3)
= 7.8147 (alpha = 0.05, df = 3)

Toxstat Version 3.5 Page____of____
Study # 60147216-445-(035-038)
ESTCP
Echinochloa crusgalli
Analysis of Plant Nutrient: SULFUR using Site Control

dk 12/14/12
QA: cw 12/14/12

Title: 60147216-445-(035-038)
File: sulf.dat Transform: NO TRANSFORMATION

ANOVA Table

SOURCE	DF	SS	MS	F
Between	3	477376875.0000	159125625.0000	3.1767
Within (Error)	12	601102500.0000	50091875.0000	
Total	15	1078479375.0000		

(p-value = 0.0634)

Critical F = 5.9525 (alpha = 0.01, df = 3,12)
= 3.4903 (alpha = 0.05, df = 3,12)

Since F < Critical F FAIL TO REJECT Ho: All equal (alpha = 0.05)

Title: 60147216-445-(035-038)
File: sulf.dat Transform: NO TRANSFORMATION

Dunnett's Test - TABLE 1 OF 2 Ho:Control=Treatment

GROUP	IDENTIFICATION	TRANSFORMED MEAN	MEAN CALCULATED IN ORIGINAL UNITS	T STAT	SIG 0.05
1	APG-15	32125.0000	32125.0000		
2	APG-02	19000.0000	19000.0000	2.6226	
3	APG-06	20875.0000	20875.0000	2.2479	
4	APG-16	19025.0000	19025.0000	2.6176	

Dunnett critical value = 2.6800 (2 Tailed, alpha = 0.05, df = 3,12)

Title: 60147216-445-(035-038)
File: sulf.dat Transform: NO TRANSFORMATION

Dunnett's Test - TABLE 2 OF 2 Ho:Control=Treatment

GROUP	IDENTIFICATION	NUM OF REPS	MIN SIG DIFF (IN ORIG. UNITS)	% OF CONTROL	DIFFERENCE FROM CONTROL
1	APG-15	4			
2	APG-02	4	999.9999	3.1	13125.0000
3	APG-06	4	999.9999	3.1	11250.0000
4	APG-16	4	999.9999	3.1	13100.0000

NOTE: MSD = 999.9999 means actual MSD estimate > 999.

Toxstat Version 3.5 Page____of____
Study # 60147216-445-(035-038)
ESTCP
Echinochloa crusgalli
Summary Statistics for Plant Nutrient: ZINC (mg/kg) using Site Control

ck 12/14/12
QA: cw 12/14/12

Title: 60147216-445-(035-038)
File: zinc.dat Transform: NO TRANSFORMATION

Summary Statistics on Data TABLE 1 of 2

GRP	IDENTIFICATION	N	MIN	MAX	MEAN
1	APG-15	4	287.0000	809.0000	600.2500
2	APG-02	4	345.0000	1870.0000	771.2500
3	APG-06	4	162.0000	392.0000	300.7500
4	APG-16	4	448.0000	1200.0000	872.7500

Title: 60147216-445-(035-038)
File: zinc.dat Transform: NO TRANSFORMATION

Summary Statistics on Data TABLE 2 of 2

GRP	IDENTIFICATION	VARIANCE	SD	SEM	C.V. %
1	APG-15	59058.2500	243.0190	121.5095	40.4863
2	APG-02	538356.9167	733.7281	366.8640	95.1349
3	APG-06	9570.2500	97.8277	48.9138	32.5279
4	APG-16	99623.5833	315.6320	157.8160	36.1652

Toxstat Version 3.5 Page____of____
Study # 60147216-445-(035-038)
ESTCP
Echinochloa crusgalli
Analysis of Plant Nutrient: ZINC using Site Control

R 12/14/12
QA: CW 12/14/12

Title: 60147216-445-(035-038)
File: zinc.dat Transform: NO TRANSFORMATION

Shapiro - Wilk's Test for Normality

D = 2119827.0000
W = 0.8535

Critical W = 0.8440 (alpha = 0.01 , N = 16)
W = 0.8870 (alpha = 0.05 , N = 16)

Data PASS normality test (alpha = 0.01). Continue analysis.

Title: 60147216-445-(035-038)
File: zinc.dat Transform: NO TRANSFORMATION

Bartlett's Test for Homogeneity of Variance

Calculated B1 statistic = 9.1395 (p-value = 0.0275)

Data PASS B1 homogeneity test at 0.01 level. Continue analysis.

Critical B = 11.3449 (alpha = 0.01, df = 3)
= 7.8147 (alpha = 0.05, df = 3)

Toxstat Version 3.5
Study # 60147216-445-(035-038)
ESTCP
Echinochloa crusgalli
Analysis of Plant Nutrient: ZINC using Site Control

Page____of____

dk 12/14/12
QA: cu 12/14/12

Title: 60147216-445-(035-038)
File: zinc.dat Transform: NO TRANSFORMATION

ANOVA Table

SOURCE	DF	SS	MS	F
Between	3	752054.0000	250684.6667	1.4191
Within (Error)	12	2119827.0000	176652.2500	
Total	15	2871881.0000		

(p-value = 0.2855)

Critical F = 5.9525 (alpha = 0.01, df = 3,12)
= 3.4903 (alpha = 0.05, df = 3,12)

Since F < Critical F FAIL TO REJECT Ho: All equal (alpha = 0.05)

Title: 60147216-445-(035-038)
File: zinc.dat Transform: NO TRANSFORMATION

Dunnett's Test - TABLE 1 OF 2 Ho:Control=Treatment

GROUP	IDENTIFICATION	TRANSFORMED MEAN	MEAN CALCULATED IN ORIGINAL UNITS	T STAT	SIG 0.05
1	APG-15	600.2500	600.2500		
2	APG-02	771.2500	771.2500	0.5754	
3	APG-06	300.7500	300.7500	1.0077	
4	APG-16	872.7500	872.7500	0.9169	

Dunnett critical value = 2.6800 (2 Tailed, alpha = 0.05, df = 3,12)

Title: 60147216-445-(035-038)
File: zinc.dat Transform: NO TRANSFORMATION

Dunnett's Test - TABLE 2 OF 2 Ho:Control=Treatment

GROUP	IDENTIFICATION	NUM OF REPS	MIN SIG DIFF (IN ORIG. UNITS)	% OF CONTROL	DIFFERENCE FROM CONTROL
1	APG-15	4			
2	APG-02	4	796.4883	132.7	171.0000
3	APG-06	4	796.4883	132.7	299.5000
4	APG-16	4	796.4883	132.7	272.5000

Toxstat Version 3.5 Page____of____
Study # 60147216-445-(035-038)
ESTCP
Echinochloa crusgalli (%)
Summary Statistics for Plant Nutrient: NITROGEN using Site Control

-R 12/14/12
QA: CW 12/14/12

Title: 60147216-445-(035-038)
File: nitro.dat Transform: NO TRANSFORMATION

Summary Statistics on Data TABLE 1 of 2

GRP	IDENTIFICATION	N	MIN	MAX	MEAN
1	APG-15	4	0.6700	0.7700	0.7300
2	APG-02	4	0.8100	0.9700	0.8775
3	APG-06	4	0.7500	0.8200	0.7850
4	APG-16	4	0.6900	0.8100	0.7650

Title: 60147216-445-(035-038)
File: nitro.dat Transform: NO TRANSFORMATION

Summary Statistics on Data TABLE 2 of 2

GRP	IDENTIFICATION	VARIANCE	SD	SEM	C.V. %
1	APG-15	0.0018	0.0424	0.0212	5.8118
2	APG-02	0.0053	0.0727	0.0364	8.2899
3	APG-06	0.0008	0.0289	0.0144	3.6774
4	APG-16	0.0028	0.0526	0.0263	6.8757

Toxstat Version 3.5 Page____of____
Study # 60147216-445-(035-038)
ESTCP
Echinochloa crusgalli
Analysis of Plant Nutrient: NITROGEN using Site Control

QA: cw 12/14/12
12/14/12

Title: 60147216-445-(035-038)
File: nitro.dat Transform: NO TRANSFORMATION

Shapiro - Wilk's Test for Normality

D = 0.0321
W = 0.9520

Critical W = 0.8440 (alpha = 0.01 , N = 16)
W = 0.8870 (alpha = 0.05 , N = 16)

Data PASS normality test (alpha = 0.01). Continue analysis.

Title: 60147216-445-(035-038)
File: nitro.dat Transform: NO TRANSFORMATION

Bartlett's Test for Homogeneity of Variance

Calculated B1 statistic = 2.2217 (p-value = 0.5277)

Data PASS B1 homogeneity test at 0.01 level. Continue analysis.

Critical B = 11.3449 (alpha = 0.01, df = 3)
= 7.8147 (alpha = 0.05, df = 3)

Toxstat Version 3.5 Page____of____
Study # 60147216-445-(035-038)
ESTCP
Echinochloa crusgalli
Analysis of Plant Nutrient: NITROGEN using Site Control

dk 12/14/12
QA: cu 12/14/12

Title: 60147216-445-(035-038)
File: nitro.dat Transform: NO TRANSFORMATION

ANOVA Table

SOURCE	DF	SS	MS	F
Between	3	0.0476	0.0159	5.9384
Within (Error)	12	0.0321	0.0027	
Total	15	0.0797		

(p-value = 0.0101)

Critical F = 5.9525 (alpha = 0.01, df = 3,12)
= 3.4903 (alpha = 0.05, df = 3,12)

Since F > Critical F REJECT Ho: All equal (alpha = 0.05)

Title: 60147216-445-(035-038)
File: nitro.dat Transform: NO TRANSFORMATION

Dunnett's Test - TABLE 1 OF 2 Ho:Control=Treatment

GROUP	IDENTIFICATION	TRANSFORMED MEAN	MEAN CALCULATED IN ORIGINAL UNITS	T STAT	SIG 0.05
1	APG-15	0.7300	0.7300		
2	APG-02	0.8775	0.8775	4.0347	*
3	APG-06	0.7850	0.7850	1.5045	
4	APG-16	0.7650	0.7650	0.9574	

Dunnett critical value = 2.6800 (2 Tailed, alpha = 0.05, df = 3,12)

Title: 60147216-445-(035-038)
File: nitro.dat Transform: NO TRANSFORMATION

Dunnett's Test - TABLE 2 OF 2 Ho:Control=Treatment

GROUP	IDENTIFICATION	NUM OF REPS	MIN SIG DIFF (IN ORIG. UNITS)	% OF CONTROL	DIFFERENCE FROM CONTROL
1	APG-15	4			
2	APG-02	4	0.0980	13.4	0.1475
3	APG-06	4	0.0980	13.4	0.0550
4	APG-16	4	0.0980	13.4	0.0350

Toxstat Version 3.5
Study # 60147216-445-(035-038)
ESTCP
Echinochloa ~~crusgalli~~ crusgalli ①
Summary Statistics for Plant Nutrient: Boron (mg/kg)

4/26/12
QA: cu 04/27/12

Title: 60147216-445-(035-038)
File: 445nuts.dat Transform: NO TRANSFORMATION

Summary Statistics on Data TABLE 1 of 2

GRP	IDENTIFICATION	N	MIN	MAX	MEAN
1	Control	4	5.8000	6.6000	6.1750
2	APG-02	4	15.3000	28.5000	19.5000
3	APG-06	4	11.3000	13.0000	12.0250
4	APG-15	4	6.9000	10.7000	9.0000
5	APG-16	4	7.3000	11.9000	10.1250

Title: 60147216-445-(035-038)
File: 445nuts.dat Transform: NO TRANSFORMATION

Summary Statistics on Data TABLE 2 of 2

GRP	IDENTIFICATION	VARIANCE	SD	SEM	C.V. %
1	Control	0.1225	0.3500	0.1750	5.6680
2	APG-02	36.7267	6.0603	3.0301	31.0782
3	APG-06	0.7425	0.8617	0.4308	7.1658
4	APG-15	2.5667	1.6021	0.8010	17.8009
5	APG-16	4.4958	2.1203	1.0602	20.9416

① Gum 07/18/12 C

Toxstat Version 3.5
Study # ~~60225262~~-445-(035-038)
ESTCP (1) 60147216
Echinochloa ~~cruegalii~~ crusgalli (1)
Determination of NOEC and LOEC for Plant Nutrient: Boron (mg/kg)

*4/27/12
QA:CW 04/30/12

Title: 60147216-445-(035-038)
File: 445nuts.dat Transform: NO TRANSFORMATION

Shapiro - Wilk's Test for Normality

D = 133.9625
W = 0.8213

Critical W = 0.8680 (alpha = 0.01 , N = 20)
W = 0.9050 (alpha = 0.05 , N = 20)

Data FAIL normality test (alpha = 0.01). Try another transformation.

Warning - The first three homogeneity tests are sensitive to non-normality and should not be performed with this data as is.

Title: 60147216-445-(035-038)
File: 445nuts.dat Transform: NO TRANSFORMATION

Bartlett's Test for Homogeneity of Variance

Calculated B1 statistic = 19.3120 (p-value = 0.0007)

Data FAIL B1 homogeneity test at 0.01 level. Try another transformation.

Critical B = 13.2767 (alpha = 0.01, df = 4)
= 9.4877 (alpha = 0.05, df = 4)

(1) corr for ANP 07/23/12 C

Toxstat Version 3.5
Study # ~~60225262-~~445-(035-038)
ESTCP (1) 60147216
Echinochloa ~~crusgallii~~ crusgalli (1)
Kruskal-Wallis Comparison for Plant Nutrient: Boron (mg/kg)

AK 4/27/12
QA:CW 04/30/12

Title: 60147216-445-(035-038)
File: 445nuts.dat Transform: NO TRANSFORMATION

Kruskal - Wallis' ANOVA by Ranks - TABLE 1 OF 2

GROUP	IDENTIFICATION	TRANSFORMED MEAN	MEAN CALCULATED IN ORIGINAL UNITS	RANK SUM
1	Control	6.1750	6.1750	10.0000
2	APG-02	19.5000	19.5000	74.0000
3	APG-06	12.0250	12.0250	54.0000
4	APG-15	9.0000	9.0000	30.0000
5	APG-16	10.1250	10.1250	42.0000

H Value = 16.6983 Critical H = 9.4877 (alpha = 0.05 , df = 4)
(p-value 0.0022)
Since Calc H > Crit H REJECT Ho:All groups are equal at alpha = 0.05

Title: 60147216-445-(035-038)
File: 445nuts.dat Transform: NO TRANSFORMATION

Dunn's Multiple Comparison - Kruskal - Wallis - TABLE 2 OF 2

GROUP	IDENTIFICATION	TRANSFORMED MEAN	ORIGINAL MEAN	GROUP 0 1	0 4	0 5	0 3	0 2
1	Control	6.1750	6.1750	\				
4	APG-15	9.0000	9.0000	.	\			
5	APG-16	10.1250	10.1250	.	.	\		
3	APG-06	12.0250	12.0250	.	.	.	\	
2	APG-02	19.5000	19.5000	*	.	.	.	\

* = significant difference (alpha = 0.05) . = no significant difference
Table q value = 2.8070 (0.05, 5) SE = 4.1817

(1) Dunn for ANP 07/23/12 C

Toxstat Version 3.5
Study # 60147216-445-(035-038)
ESTCP
Echinochloa ~~*erusgalli*~~ crusgalli ①
Summary Statistics for Plant Nutrient: Calcium (mg/kg)

dk 4/26/12
QA:cw 04/30/12

Title: 60225262-445-calcium
File: 445nutca.dat Transform: NO TRANSFORMATION

Summary Statistics on Data TABLE 1 of 2

GRP	IDENTIFICATION	N	MIN	MAX	MEAN
1	Control	4	16600.0000	23200.0000	19750.0000
2	APG-02	4	6770.0000	22400.0000	10912.5000
3	APG-06	4	9170.0000	24500.0000	13745.0000
4	APG-15	4	21400.0000	44200.0000	32200.0000
5	APG-16	4	15800.0000	17300.0000	16575.0000

Title: 60225262-445-calcium
File: 445nutca.dat Transform: NO TRANSFORMATION

Summary Statistics on Data TABLE 2 of 2

GRP	IDENTIFICATION	VARIANCE	SD	SEM	C.V. %
1	Control	7316666.6667	2704.9338	1352.4669	13.6959
2	APG-02	58700225.0000	7661.6072	3830.8036	70.2095
3	APG-06	52932300.0000	7275.4587	3637.7294	52.9317
4	APG-15	129786666.6666	11392.3951	5696.1976	35.3801
5	APG-16	482500.0000	694.6222	347.3111	4.1908

① GRM for ANP 07/23/12 C

Toxstat Version 3.5
Study # ~~60225262~~-445-(035-038)
ESTCP ①60147216
Echinochloa crusgalli ~~crusgalli~~ ①
Determination of NOEC and LOEC for Plant Nutrient: Calcium (mg/kg)

QA: CW 04/30/12
4/27/12

Title: 60225262-445-calcium
File: 445nutca.dat Transform: NO TRANSFORMATION

Shapiro - Wilk's Test for Normality

D = 747655075.0000
W = 0.9183

Critical W = 0.8680 (alpha = 0.01 , N = 20)
W = 0.9050 (alpha = 0.05 , N = 20)

Data PASS normality test (alpha = 0.01). Continue analysis.

Title: 60225262-445-calcium
File: 445nutca.dat Transform: NO TRANSFORMATION

Bartlett's Test for Homogeneity of Variance

Calculated B1 statistic = 14.2299 (p-value = 0.0066)

Data FAIL B1 homogeneity test at 0.01 level. Try another transformation.

Critical B = 13.2767 (alpha = 0.01, df = 4)
= 9.4877 (alpha = 0.05, df = 4)

① mm 07/23/12 C for ANP

Toxstat Version 3.5
Study # ~~60225262~~-445-(035-038)
ESTCP (1) 60147216
Echinochloa ~~crusgalii~~ crusgalli (1)
Kruskal-Wallis Comparison for Plant Nutrient: Calcium (mg/kg)

dk 4/27/12
QA: cu 04/30/12

Title: 60225262-445-calcium
File: 445nutca.dat Transform: NO TRANSFORMATION

Kruskal - Wallis' ANOVA by Ranks - TABLE 1 OF 2

GROUP	IDENTIFICATION	TRANSFORMED MEAN	MEAN CALCULATED IN ORIGINAL UNITS	RANK SUM
1	Control	19750.0000	19750.0000	50.0000
2	APG-02	10912.5000	10912.5000	21.0000
3	APG-06	13745.0000	13745.0000	33.0000
4	APG-15	32200.0000	32200.0000	70.0000
5	APG-16	16575.0000	16575.0000	36.0000

H Value = 10.0429 Critical H = 9.4877 (alpha = 0.05 , df = 4)
(p-value 0.0397)
Since Calc H > Crit H REJECT Ho:All groups are equal at alpha = 0.05

Title: 60225262-445-calcium
File: 445nutca.dat Transform: NO TRANSFORMATION

Dunn's Multiple Comparison - Kruskal - Wallis - TABLE 2 OF 2

GROUP	IDENTIFICATION	TRANSFORMED MEAN	ORIGINAL MEAN	GROUP 0 0 0 0 0 2 3 5 1 4
2	APG-02	10912.5000	10912.5000	\
3	APG-06	13745.0000	13745.0000	. . \
5	APG-16	16575.0000	16575.0000	. . \
1	Control	19750.0000	19750.0000	. . . \
4	APG-15	32200.0000	32200.0000	* . . . \

* = significant difference (alpha = 0.05) . = no significant difference
Table q value = 2.8070 (0.05, 5) SE = 4.1833

(1) own for ANP 07/23/12

Toxstat Version 3.5
Study # 60147216-445-(035-038)
ESTCP
Echinochloa ~~*grusgalii*~~ crusgalli ①
Summary Statistics for Plant Nutrient Copper (mg/kg)

4/26/12
QA:CJ 04/30/12

Title: 60225262-445-copper
File: 445nutCu.dat Transform: NO TRANSFORMATION

Summary Statistics on Data TABLE 1 of 2

GRP	IDENTIFICATION	N	MIN	MAX	MEAN
1	Control	4	1.8000	2.9000	2.2750
2	APG-02	4	13.2000	26.9000	20.6750
3	APG-06	4	5.3000	9.1000	7.0500
4	APG-15	4	11.4000	24.4000	15.5500
5	APG-16	4	8.5000	10.5000	9.5750

Title: 60225262-445-copper
File: 445nutCu.dat Transform: NO TRANSFORMATION

Summary Statistics on Data TABLE 2 of 2

GRP	IDENTIFICATION	VARIANCE	SD	SEM	C.V. %
1	Control	0.2358	0.4856	0.2428	21.3462
2	APG-02	47.8092	6.9144	3.4572	33.4434
3	APG-06	2.5433	1.5948	0.7974	22.6210
4	APG-15	35.9567	5.9964	2.9982	38.5620
5	APG-16	0.9558	0.9777	0.4888	10.2106

① GMM 07/23/12 C

Toxstat Version 3.5
Study # ~~60225262~~-445-(035-038)
ESTCP ① 60147216
Echinochloa ~~*crusgalii*~~ crusgalli ①
Determination of NOEC and LOEC for Plant Nutrient: Copper (mg/kg)

QA: CW 04/30/12
4/27/12

Title: 60225262-445-copper
File: 445nutcu.dat Transform: NO TRANSFORMATION

Shapiro - Wilk's Test for Normality

D = 262.5025
W = 0.9369

Critical W = 0.8680 (alpha = 0.01 , N = 20)
W = 0.9050 (alpha = 0.05 , N = 20)

Data PASS normality test (alpha = 0.01). Continue analysis.

Title: 60225262-445-copper
File: 445nutcu.dat Transform: NO TRANSFORMATION

Bartlett's Test for Homogeneity of Variance

Calculated B1 statistic = 19.6355 (p-value = 0.0006)

Data FAIL B1 homogeneity test at 0.01 level. Try another transformation.

Critical B = 13.2767 (alpha = 0.01, df = 4)
= 9.4877 (alpha = 0.05, df = 4)

① GMM for ANP 07/23/12 C

Toxstat Version 3.5
Study # ~~60225262~~-445-(035-038)
ESTCP ① 60147216
Echinochloa ~~grusgalli~~ crusgalli ①
Kruskal-Wallis Comparison for Plant Nutrient: Copper (mg/kg)

4/27/12
QA:CW 04/30/12

Title: 60225262-445-copper
File: 445nutcu.dat Transform: NO TRANSFORMATION

Kruskal - Wallis' ANOVA by Ranks - TABLE 1 OF 2

GROUP	IDENTIFICATION	TRANSFORMED MEAN	MEAN CALCULATED IN ORIGINAL UNITS	RANK SUM
1	Control	2.2750	2.2750	10.0000
2	APG-02	20.6750	20.6750	71.0000
3	APG-06	7.0500	7.0500	28.0000
4	APG-15	15.5500	15.5500	61.0000
5	APG-16	9.5750	9.5750	40.0000

H Value = 17.3286 Critical H = 9.4877 (alpha = 0.05 , df = 4)
(p-value 0.0017)
Since Calc H > Crit H REJECT Ho:All groups are equal at alpha = 0.05

Title: 60225262-445-copper
File: 445nutcu.dat Transform: NO TRANSFORMATION

Dunn's Multiple Comparison - Kruskal - Wallis - TABLE 2 OF 2

GROUP	IDENTIFICATION	TRANSFORMED MEAN	ORIGINAL MEAN	GROUP 0 1	0 3	0 5	0 4	0 2
1	Control	2.2750	2.2750	\				
3	APG-06	7.0500	7.0500	.	\			
5	APG-16	9.5750	9.5750	.	.	\		
4	APG-15	15.5500	15.5500	*	.	.	\	
2	APG-02	20.6750	20.6750	*	.	.	.	\

* = significant difference (alpha = 0.05) . = no significant difference
Table q value = 2.8070 (0.05, 5) SE = 4.1833

① CWM 07/23/12 C for ANP

Toxstat Version 3.5
Study # 60147216-445-(035-038)
ESTCP
Echinochloa ~~*crusgallii*~~ crusgalli ①
Summary Statistics for Plant Nutrient: Iron (mg/kg)

QA:CW 04/30/12
[illegible] 4/26/12

Title: 60225262-445-Iron
File: 445nutFe.dat Transform: NO TRANSFORMATION

Summary Statistics on Data TABLE 1 of 2

GRP	IDENTIFICATION	N	MIN	MAX	MEAN
1	Control	4	41.8000	64.7000	51.8500
2	APG-02	4	91.3000	415.0000	250.0750
3	APG-06	4	121.0000	281.0000	173.2500
4	APG-15	4	61.7000	196.0000	114.9250
5	APG-16	4	53.5000	185.0000	108.7500

Title: 60225262-445-Iron
File: 445nutFe.dat Transform: NO TRANSFORMATION

Summary Statistics on Data TABLE 2 of 2

GRP	IDENTIFICATION	VARIANCE	SD	SEM	C.V. %
1	Control	90.2167	9.4982	4.7491	18.3187
2	APG-02	24276.8892	155.8104	77.9052	62.3055
3	APG-06	5661.5833	75.2435	37.6217	43.4306
4	APG-15	3275.2892	57.2301	28.6151	49.7978
5	APG-16	3344.4167	57.8309	28.9155	53.1779

① owm for ANP 07/23/12 C

Toxstat Version 3.5
Study # ~~60225262~~-445-(035-038)
ESTCP ① 60147216
Echinochloa ~~crusgalii~~ crusgalli ①
Determination of NOEC and LOEC for Plant Nutrient: Iron (mg/kg)

QA: CJ 04/30/12
4/27/12

```
Title:  60225262-445-Iron
File:      445nutFe.dat              Transform:              NO TRANSFORMATION

                     Shapiro - Wilk's Test for Normality
-----------------------------------------------------------------------------

     D = 109945.1850
     W =   0.9596

     Critical W  = 0.8680 (alpha = 0.01 , N = 20)
              W  = 0.9050 (alpha = 0.05 , N = 20)

-----------------------------------------------------------------------------

Data PASS normality test (alpha = 0.01). Continue analysis.


Title:  60225262-445-Iron
File:      445nutFe.dat              Transform:              NO TRANSFORMATION

                  Bartlett's Test for Homogeneity of Variance
-----------------------------------------------------------------------------

Calculated B1 statistic = 13.3631              (p-value = 0.0096)

Data FAIL B1 homogeneity test at 0.01 level. Try another transformation.

-----------------------------------------------------------------------------

Critical B = 13.2767  (alpha = 0.01, df =  4)
           =  9.4877  (alpha = 0.05, df =  4)
```

① GKM for ANP 07/23/12 C

Toxstat Version 3.5
Study # ~~60225262~~-445-(035-038)
ESTCP (1) 60147216
Echinochloa ~~crusgalli~~ crusgalli (1)
Kruskal-Wallis Comparison for Plant Nutrient: Iron (mg/kg)

QA: cw 04/30/12
4/27/12

Title: 60225262-445-Iron
File: 445nutFe.dat Transform: NO TRANSFORMATION

Kruskal - Wallis' ANOVA by Ranks - TABLE 1 OF 2

GROUP	IDENTIFICATION	TRANSFORMED MEAN	MEAN CALCULATED IN ORIGINAL UNITS	RANK SUM
1	Control	51.8500	51.8500	12.0000
2	APG-02	250.0750	250.0750	61.0000
3	APG-06	173.2500	173.2500	58.0000
4	APG-15	114.9250	114.9250	41.0000
5	APG-16	108.7500	108.7500	38.0000

H Value = 10.9571 Critical H = 9.4877 (alpha = 0.05 , df = 4)
(p-value 0.0270)
Since Calc H > Crit H REJECT Ho:All groups are equal at alpha = 0.05

Title: 60225262-445-Iron
File: 445nutFe.dat Transform: NO TRANSFORMATION

Dunn's Multiple Comparison - Kruskal - Wallis - TABLE 2 OF 2

GROUP	IDENTIFICATION	TRANSFORMED MEAN	ORIGINAL MEAN	GROUP 0 1	0 5	0 4	0 3	0 2
1	Control	51.8500	51.8500	\				
5	APG-16	108.7500	108.7500	.	\			
4	APG-15	114.9250	114.9250	.	.	\		
3	APG-06	173.2500	173.2500	.	.	.	\	
2	APG-02	250.0750	250.0750	*	.	.	.	\

* = significant difference (alpha = 0.05) . = no significant difference
Table q value = 2.8070 (0.05, 5) SE = 4.1833

(1) mm for ANP 07/23/12 c

Toxstat Version 3.5
Study # 60~~1~~147216-445-(035-038)
ESTCP
Echinochloa ~~cursgalii~~ crusgalli
Summary Statistics for Plant Nutrient: Magnesium (mg/kg)

QA:cw 04/30/12
4/26/12

Title: 60225262-445-Magnesium
File: 445nutmg.dat Transform: NO TRANSFORMATION

Summary Statistics on Data TABLE 1 of 2

GRP	IDENTIFICATION	N	MIN	MAX	MEAN
1	Control	4	10200.0000	12500.0000	10950.0000
2	APG-02	4	10700.0000	12900.0000	11900.0000
3	APG-06	4	11300.0000	14900.0000	13950.0000
4	APG-15	4	9340.0000	10500.0000	10085.0000
5	APG-16	4	7870.0000	9380.0000	8417.5000

Title: 60225262-445-Magnesium
File: 445nutmg.dat Transform: NO TRANSFORMATION

Summary Statistics on Data TABLE 2 of 2

GRP	IDENTIFICATION	VARIANCE	SD	SEM	C.V. %
1	Control	1110000.0000	1053.5654	526.7827	9.6216
2	APG-02	1146666.6667	1070.8252	535.4126	8.9985
3	APG-06	3123333.3333	1767.2955	883.6477	12.6688
4	APG-15	275566.6667	524.9444	262.4722	5.2052
5	APG-16	456691.6667	675.7897	337.8948	8.0284

① GNm-Ar NVP 07/23/12 C

Toxstat Version 3.5
Study # ~~60225262~~-445-(035-038)
ESTCP ① 60147216
Echinochloa ~~crusgalli~~ crusgalli
Determination of NOEC and LOEC for Plant Nutrient: Magnesium (mg/kg)

4/27/12
QA: CW 04/30/12

Title: 60225262-445-Magnesium
File: 445nutmg.dat Transform: NO TRANSFORMATION

Shapiro - Wilk's Test for Normality

D = 18336775.0000
W = 0.9329

Critical W = 0.8680 (alpha = 0.01 , N = 20)
W = 0.9050 (alpha = 0.05 , N = 20)

Data PASS normality test (alpha = 0.01). Continue analysis.

Title: 60225262-445-Magnesium
File: 445nutmg.dat Transform: NO TRANSFORMATION

Bartlett's Test for Homogeneity of Variance

Calculated B1 statistic = 4.4916 (p-value = 0.3435)

Data PASS B1 homogeneity test at 0.01 level. Continue analysis.

Critical B = 13.2767 (alpha = 0.01, df = 4)
= 9.4877 (alpha = 0.05, df = 4)

① Mm for ANP 07/23/12 C

Toxstat Version 3.5
Study # 60~~1~~2147216-445-(035-038)
ESTCP ①
Echinochloa ~~cursgalii~~ crusgalli ①
Tukey Comparison for Plant Nutrient: Magnesium (mg/kg)

QA: cu 04/30/12
JK 4/26/12

Title: 60225262-445-Magnesium
File: 445nutmg.dat Transform: NO TRANSFORMATION

ANOVA Table

SOURCE	DF	SS	MS	F
Between	4	68012920.0000	17003230.0000	13.9091
Within (Error)	15	18336775.0000	1222451.6667	
Total	19	86349695.0000		

(p-value = 0.0001)

Critical F = 4.8932 (alpha = 0.01, df = 4,15)
= 3.0556 (alpha = 0.05, df = 4,15)

Since F > Critical F REJECT Ho: All equal (alpha = 0.05)

Title: 60225262-445-Magnesium
File: 445nutmg.dat Transform: NO TRANSFORMATION

Tukey Method of Multiple Comparisons

GROUP	IDENTIFICATION	TRANSFORMED MEAN	ORIGINAL MEAN	GROUP 0 5	0 4	0 1	0 2	0 3
5	APG-16	8417.5000	8417.5000	\				
4	APG-15	10085.0000	10085.0000	.	\			
1	Control	10950.0000	10950.0000	*	.	\		
2	APG-02	11900.0000	11900.0000	*	.	.	\	
3	APG-06	13950.0000	13950.0000	*	*	*	.	\

* = significant difference (alpha = 0.05) . = no significant difference

Tukey critical value = 4.3670 (df = 5,15) s = 1222451.6667

① mm 07/23/12 C
for ANP

Toxstat Version 3.5
Study # 60147216-445-(035-038)
ESTCP
Echinochloa ~~*grusgalii*~~ crusgalli ①
Summary Statistics for Plant Nutrient: Manganese (mg/kg)

do 4/26/12
QA: cw 04/30/12

Title: 60147216-445-Manganese
File: 445nutMn.dat Transform: NO TRANSFORMATION

Summary Statistics on Data TABLE 1 of 2

GRP	IDENTIFICATION	N	MIN	MAX	MEAN
1	Control	4	167.0000	263.0000	205.5000
2	APG-02	4	1160.0000	2370.0000	1742.5000
3	APG-06	4	181.0000	880.0000	440.7500
4	APG-15	4	342.0000	496.0000	424.0000
5	APG-16	4	245.0000	666.0000	512.2500

Title: 60147216-445-Manganese
File: 445nutMn.dat Transform: NO TRANSFORMATION

Summary Statistics on Data TABLE 2 of 2

GRP	IDENTIFICATION	VARIANCE	SD	SEM	C.V. %
1	Control	1689.0000	41.0974	20.5487	19.9988
2	APG-02	321758.3333	567.2375	283.6187	32.5531
3	APG-06	96024.2500	309.8778	154.9389	70.3069
4	APG-15	4028.6667	63.4718	31.7359	14.9698
5	APG-16	35434.9167	188.2416	94.1208	36.7480

① mm for ANP 07/23/12 C

Toxstat Version 3.5
Study # ~~60225262~~-445-(035-038)
ESTCP ① 60147216
Echinochloa ~~erusgalii~~ crusgalli ①
Determination of NOEC and LOEC for Plant Nutrient: Manganese (mg/kg)

4/27/12
QA:CW 04/30/12

```
Title:  60147216-445-Manganese
File:      445nutMn.dat              Transform:             NO TRANSFORMATION

                   Shapiro - Wilk's Test for Normality
-----------------------------------------------------------------------------

     D = 1376805.5000
     W =   0.9531

     Critical W  = 0.8680 (alpha = 0.01 , N = 20)
              W  = 0.9050 (alpha = 0.05 , N = 20)

-----------------------------------------------------------------------------

Data PASS normality test (alpha = 0.01). Continue analysis.


Title:  60147216-445-Manganese
File:      445nutMn.dat              Transform:             NO TRANSFORMATION

                Bartlett's Test for Homogeneity of Variance
-----------------------------------------------------------------------------

Calculated B1 statistic = 17.9303               (p-value = 0.0013)

Data FAID B1 homogeneity test at 0.01 level. Try another transformation.

-----------------------------------------------------------------------------

Critical B = 13.2767  (alpha = 0.01, df =  4)
           =  9.4877  (alpha = 0.05, df =  4)
```

① crm for ANP 07/23/12 C

Toxstat Version 3.5
Study # ~~60225262~~-445-(035-038)
ESTCP ①60147216
Echinochloa ~~crusgalii~~ crusgalli ①
Kruskal-Wallis Comparison for Plant Nutrient: Manganese (mg/kg)

QA:cw 04/30/12
4/27/12

Title: 60147216-445-Manganese
File: 445nutMn.dat Transform: NO TRANSFORMATION

Kruskal - Wallis' ANOVA by Ranks - TABLE 1 OF 2

GROUP	IDENTIFICATION	TRANSFORMED MEAN	MEAN CALCULATED IN ORIGINAL UNITS	RANK SUM
1	Control	205.5000	205.5000	14.0000
2	APG-02	1742.5000	1742.5000	74.0000
3	APG-06	440.7500	440.7500	35.0000
4	APG-15	424.0000	424.0000	40.0000
5	APG-16	512.2500	512.2500	47.0000

H Value = 13.4714 Critical H = 9.4877 (alpha = 0.05 , df = 4)
(p-value 0.0092)
Since Calc H > Crit H REJECT Ho:All groups are equal at alpha = 0.05

Title: 60147216-445-Manganese
File: 445nutMn.dat Transform: NO TRANSFORMATION

Dunn's Multiple Comparison - Kruskal - Wallis - TABLE 2 OF 2

GROUP	IDENTIFICATION	TRANSFORMED MEAN	ORIGINAL MEAN	GROUP 0 1	0 4	0 3	0 5	0 2
1	Control	205.5000	205.5000	\				
4	APG-15	424.0000	424.0000	.	\			
3	APG-06	440.7500	440.7500	.	.	\		
5	APG-16	512.2500	512.2500	.	.	.	\	
2	APG-02	1742.5000	1742.5000	*	.	.	.	\

* = significant difference (alpha = 0.05) . = no significant difference
Table q value = 2.8070 (0.05, 5) SE = 4.1833

①GWM for ANP 07/23/12 LC

Toxstat Version 3.5
Study # 60147216-445-(035-038)
ESTCP
Echinochloa ~~*crusgalii*~~ crusgalli ①
Summary Statistics for Plant Nutrient: Phosphorus (mg/kg)

4/26/12
QA:CJ 04/30/12

Title: 60147216-445-Phosphorus
File: 445nutp.dat Transform: NO TRANSFORMATION

Summary Statistics on Data TABLE 1 of 2

GRP	IDENTIFICATION	N	MIN	MAX	MEAN
1	Control	4	2440.0000	3160.0000	2875.0000
2	APG-02	4	1920.0000	2660.0000	2302.5000
3	APG-06	4	1930.0000	2360.0000	2090.0000
4	APG-15	4	1730.0000	2090.0000	1915.0000
5	APG-16	4	1440.0000	2070.0000	1757.5000

Title: 60147216-445-Phosphorus
File: 445nutp.dat Transform: NO TRANSFORMATION

Summary Statistics on Data TABLE 2 of 2

GRP	IDENTIFICATION	VARIANCE	SD	SEM	C.V. %
1	Control	117966.6667	343.4628	171.7314	11.9465
2	APG-02	91491.6667	302.4759	151.2379	13.1368
3	APG-06	34866.6667	186.7262	93.3631	8.9343
4	APG-15	34700.0000	186.2794	93.1397	9.7274
5	APG-16	66758.3333	258.3763	129.1882	14.7014

① Grm for ANP 07/23/12C

Toxstat Version 3.5
Study # ~~60225262~~-445-(035-038)
ESTCP ① 60147216
Echinochloa ~~*crusgalii*~~ crusgalli ①
Determination of NOEC and LOEC for Plant Nutrient: Phosphorus(mg/kg) QA:CW 04/30/12
K4/27/12

Title: 60147216-445-Phosphorus
File: 445nutp.dat Transform: NO TRANSFORMATION

Shapiro - Wilk's Test for Normality

D = 1037350.0000
W = 0.9582

Critical W = 0.8680 (alpha = 0.01 , N = 20)
W = 0.9050 (alpha = 0.05 , N = 20)

Data PASS normality test (alpha = 0.01). Continue analysis.

Title: 60147216-445-Phosphorus
File: 445nutp.dat Transform: NO TRANSFORMATION

Bartlett's Test for Homogeneity of Variance

Calculated B1 statistic = 1.5773 (p-value = 0.8129)

Data PASS B1 homogeneity test at 0.01 level. Continue analysis.

Critical B = 13.2767 (alpha = 0.01, df = 4)
= 9.4877 (alpha = 0.05, df = 4)

① oxm for ANP 07/23/12.C

Toxstat Version 3.5
Study # 60147216-445-(035-038)
ESTCP
Echinochloa ~~*crusgalii*~~ crusgalli (1)
Tukey Comparison for Plant Nutrient: Phosphorus (mg/kg)

QA: CW 04/30/12
dc 4/26/12

Title: 60147216-445-Phosphorus
File: 445nutp.dat Transform: NO TRANSFORMATION

ANOVA Table

SOURCE	DF	SS	MS	F
Between	4	3018170.0000	754542.5000	10.9106
Within (Error)	15	1037350.0000	69156.6667	
Total	19	4055520.0000		

(p-value = 0.0002)

Critical F = 4.8932 (alpha = 0.01, df = 4,15)
= 3.0556 (alpha = 0.05, df = 4,15)

Since F > Critical F REJECT Ho: All equal (alpha = 0.05)

Title: 60147216-445-Phosphorus
File: 445nutp.dat Transform: NO TRANSFORMATION

Tukey Method of Multiple Comparisons

GROUP	IDENTIFICATION	TRANSFORMED MEAN	ORIGINAL MEAN	GROUP 0 5	0 4	0 3	0 2	0 1
5	APG-16	1757.5000	1757.5000	\				
4	APG-15	1915.0000	1915.0000	.	\			
3	APG-06	2090.0000	2090.0000	.	.	\		
2	APG-02	2302.5000	2302.5000	.	.	.	\	
1	Control	2875.0000	2875.0000	*	*	*	.	\

* = significant difference (alpha = 0.05) . = no significant difference

Tukey critical value = 4.3670 (df = 5,15) s = 69156.6667

(1) omm for ANP 07/23/12C

Toxstat Version 3.5
Study # 60147216-445-(035-038)
ESTCP
Echinochloa ~~*grusgalii*~~ crusgalli (1)
Summary Statistics for Plant Nutrient: Potassium (mg/kg)

dk 4/26/12
QA:cw 04/30/12

Title: 60147216-445-Potassium
File: 445nutK.dat Transform: NO TRANSFORMATION

Summary Statistics on Data TABLE 1 of 2

GRP	IDENTIFICATION	N	MIN	MAX	MEAN
1	Control	4	14400.0000	18800.0000	15750.0000
2	APG-02	4	14900.0000	18300.0000	16650.0000
3	APG-06	4	16500.0000	19900.0000	17975.0000
4	APG-15	4	14300.0000	18300.0000	16725.0000
5	APG-16	4	12700.0000	18900.0000	16225.0000

Title: 60147216-445-Potassium
File: 445nutK.dat Transform: NO TRANSFORMATION

Summary Statistics on Data TABLE 2 of 2

GRP	IDENTIFICATION	VARIANCE	SD	SEM	C.V. %
1	Control	4216666.6667	2053.4524	1026.7262	13.0378
2	APG-02	2170000.0000	1473.0920	736.5460	8.8474
3	APG-06	3035833.3333	1742.3643	871.1821	9.6933
4	APG-15	3389166.6667	1840.9689	920.4845	11.0073
5	APG-16	9449166.6667	3073.9497	1536.9748	18.9458

(1) srw for AWP 07/23/12 c

Toxstat Version 3.5
Study # ~~60225262~~-445-(035-038)
ESTCP ① 60147216
Echinochloa ~~*erusgalii*~~ crusgalli ①
Determination of NOEC and LOEC for Plant Nutrient: Potassium (mg/kg)

QA: cw 04/30/12
dk 4/27/12

```
Title:  60147216-445-Potassium
File:       445nutk.dat            Transform:            NO TRANSFORMATION

                    Shapiro - Wilk's Test for Normality
--------------------------------------------------------------------------

    D = 66782500.0000
    W =    0.9530

    Critical W  = 0.8680 (alpha = 0.01 , N = 20)
             W  = 0.9050 (alpha = 0.05 , N = 20)

--------------------------------------------------------------------------

Data PASS normality test (alpha = 0.01). Continue analysis.


Title:  60147216-445-Potassium
File:       445nutk.dat            Transform:            NO TRANSFORMATION

                 Bartlett's Test for Homogeneity of Variance
--------------------------------------------------------------------------

Calculated B1 statistic =  1.7899              (p-value = 0.7743)

Data PASS B1 homogeneity test at 0.01 level. Continue analysis.

--------------------------------------------------------------------------

Critical B = 13.2767  (alpha = 0.01, df =  4)
           =  9.4877  (alpha = 0.05, df =  4)
```

① GUM for ANP 07/23/12 C

Toxstat Version 3.5
Study # 60147216-445-(035-038)
ESTCP
Echinochloa ~~*crusgalii*~~ crusgalli (1)
Tukey Comparison for Plant Nutrient: Potassium (mg/kg)

QA: CW 04/30/12
4/26/12

Title: 60147216-445-Potassium
File: 445nutK.dat Transform: NO TRANSFORMATION

ANOVA Table

SOURCE	DF	SS	MS	F
Between	4	11003000.0000	2750750.0000	0.6178
Within (Error)	15	66782500.0000	4452166.6667	
Total	19	77785500.0000		

(p-value = 0.6566)

Critical F = 4.8932 (alpha = 0.01, df = 4,15)
= 3.0556 (alpha = 0.05, df = 4,15)

Since F < Critical F FAIL TO REJECT Ho: All equal (alpha = 0.05)

Title: 60147216-445-Potassium
File: 445nutK.dat Transform: NO TRANSFORMATION

Tukey Method of Multiple Comparisons

GROUP	IDENTIFICATION	TRANSFORMED MEAN	ORIGINAL MEAN	GROUP 0 1	0 5	0 2	0 4	0 3
1	Control	15750.0000	15750.0000	\				
5	APG-16	16225.0000	16225.0000	.	\			
2	APG-02	16650.0000	16650.0000	.	.	\		
4	APG-15	16725.0000	16725.0000	.	.	.	\	
3	APG-06	17975.0000	17975.0000	.	.	.	.	\

* = significant difference (alpha = 0.05) . = no significant difference

Tukey critical value = 4.3670 (df = 5,15) s = 4452166.6667

(1) Cum for ANP 07/23/12 C

Toxstat Version 3.5
Study # 60147216-445-(035-038)
ESTCP
Echinochloa ~~*erusgalii*~~ crusgalli ①
Summary Statistics for Plant Nutrient: Sodium (mg/kg)

ck 4/26/12
QA: cw 04/30/12

Title: 60147216-445-Sodium
File: 445nutNa.dat Transform: NO TRANSFORMATION

Summary Statistics on Data TABLE 1 of 2

GRP	IDENTIFICATION	N	MIN	MAX	MEAN
1	Control	4	84.4000	124.0000	99.1250
2	APG-02	4	946.0000	6260.0000	2579.0000
3	APG-06	4	727.0000	4000.0000	2304.2500
4	APG-15	4	3490.0000	11200.0000	6175.0000
5	APG-16	4	3700.0000	5810.0000	5050.0000

Title: 60147216-445-Sodium
File: 445nutNa.dat Transform: NO TRANSFORMATION

Summary Statistics on Data TABLE 2 of 2

GRP	IDENTIFICATION	VARIANCE	SD	SEM	C.V. %
1	Control	315.5025	17.7624	8.8812	17.9192
2	APG-02	6170684.0000	2484.0861	1242.0431	96.3197
3	APG-06	1995452.2500	1412.6048	706.3024	61.3043
4	APG-15	12001366.6667	3464.2989	1732.1494	56.1020
5	APG-16	878466.6667	937.2655	468.6328	18.5597

① corr for ANP 07/23/12 C

Toxstat Version 3.5
Study # ~~60225262~~ 60147216 -445-(035-038)
ESTCP
Echinochloa ~~*crusgalii*~~ crusgalli
Determination of NOEC and LOEC for Plant Nutrient: Sodium (mg/kg)

QA1CW 04/30/12
[illegible] 4/27/12

Title: 60147216-445-Sodium
File: 445nutna.dat Transform: NO TRANSFORMATION

Shapiro - Wilk's Test for Normality

D = 63138855.2575
W = 0.8808

Critical W = 0.8680 (alpha = 0.01 , N = 20)
W = 0.9050 (alpha = 0.05 , N = 20)

Data PASS normality test (alpha = 0.01). Continue analysis.

Title: 60147216-445-Sodium
File: 445nutna.dat Transform: NO TRANSFORMATION

Bartlett's Test for Homogeneity of Variance

Calculated B1 statistic = 27.4808 (p-value = 0.0000)

Data FAIL B1 homogeneity test at 0.01 level. Try another transformation.

Critical B = 13.2767 (alpha = 0.01, df = 4)
= 9.4877 (alpha = 0.05, df = 4)

(1) GKM for ANP 07/23/12 C

(1) [illegible] 4/27/12 E

Toxstat Version 3.5
Study # ~~60225262~~ -445-(035-038) ① 60147216
ESTCP
Echinochloa ~~crusgalii~~ crusgalli ①
Kruskal-Wallis Comparison for Plant Nutrient: Sodium (mg/kg)

QA: CW 04/30/12
[initials] 4/27/12

Title: 60147216-445-Sodium
File: 445nutna.dat   Transform: NO TRANSFORMATION

Kruskal - Wallis' ANOVA by Ranks - TABLE 1 OF 2

GROUP	IDENTIFICATION	TRANSFORMED MEAN	MEAN CALCULATED IN ORIGINAL UNITS	RANK SUM
1	Control	99.1250	99.1250	10.0000
2	APG-02	2579.0000	2579.0000	41.0000
3	APG-06	2304.2500	2304.2500	36.0000
4	APG-15	6175.0000	6175.0000	62.0000
5	APG-16	5050.0000	5050.0000	61.0000

H Value = 13.0143 Critical H = 9.4877 (alpha = 0.05 , df = 4)
(p-value 0.0112)
Since Calc H > Crit H REJECT Ho:All groups are equal at alpha = 0.05

Title: 60147216-445-Sodium
File: 445nutna.dat   Transform: NO TRANSFORMATION

Dunn's Multiple Comparison - Kruskal - Wallis - TABLE 2 OF 2

GROUP	IDENTIFICATION	TRANSFORMED MEAN	ORIGINAL MEAN	GROUP 0 1	0 3	0 2	0 5	0 4
1	Control	99.1250	99.1250	\				
3	APG-06	2304.2500	2304.2500	.	\			
2	APG-02	2579.0000	2579.0000	.	.	\		
5	APG-16	5050.0000	5050.0000	*	.	.	\	
4	APG-15	6175.0000	6175.0000	*	.	.	.	\

* = significant difference (alpha = 0.05)   . = no significant difference
Table q value = 2.8070 (0.05, 5)   SE = 4.1833

① ommfor ANP 07/23/12 C

Toxstat Version 3.5
Study # 60147216-445-(035-038)
ESTCP
Echinochloa ~~erusgalli~~ crusgalli ①
Summary Statistics for Plant Nutrient: Sulfur (mg/kg)

dk 4/26/12
QA: CW 04/30/12

Title: 60147216-445-Sulfur
File: 445nutSu.dat Transform: NO TRANSFORMATION

Summary Statistics on Data TABLE 1 of 2

GRP	IDENTIFICATION	N	MIN	MAX	MEAN
1	Control	4	3440.0000	5070.0000	4247.5000
2	APG-02	4	13200.0000	32400.0000	19000.0000
3	APG-06	4	15600.0000	28900.0000	20875.0000
4	APG-15	4	23600.0000	42900.0000	32125.0000
5	APG-16	4	18200.0000	19800.0000	19025.0000

Title: 60147216-445-Sulfur
File: 445nutSu.dat Transform: NO TRANSFORMATION

Summary Statistics on Data TABLE 2 of 2

GRP	IDENTIFICATION	VARIANCE	SD	SEM	C.V. %
1	Control	529291.6667	727.5243	363.7622	17.1283
2	APG-02	81653333.3334	9036.2234	4518.1117	47.5591
3	APG-06	32009166.6667	5657.6644	2828.8322	27.1026
4	APG-15	86195833.3334	9284.1711	4642.0856	28.9001
5	APG-16	509166.6667	713.5592	356.7796	3.7506

① GUM for AMP 07/23/12 C

Toxstat Version 3.5
Study # ~~60225262~~-445-(035-038)
ESTCP ① 60147216
Echinochloa ~~crusgalii~~ crusgalli ①
Determination of NOEC and LOEC for Plant Nutrient: Sulfur(mg/kg)

QA: CW 04/30/12
AK 4/27/12

Title: 60147216-445-Sulfur
File: 445nutsu.dat Transform: NO TRANSFORMATION

Shapiro - Wilk's Test for Normality

D = 602690375.0000
W = 0.9121

Critical W = 0.8680 (alpha = 0.01 , N = 20)
W = 0.9050 (alpha = 0.05 , N = 20)

Data PASS normality test (alpha = 0.01). Continue analysis.

Title: 60147216-445-Sulfur
File: 445nutsu.dat Transform: NO TRANSFORMATION

Bartlett's Test for Homogeneity of Variance

Calculated B1 statistic = 19.7281 (p-value = 0.0006)

Data FAIL B1 homogeneity test at 0.01 level. Try another transformation.

Critical B = 13.2767 (alpha = 0.01, df = 4)
= 9.4877 (alpha = 0.05, df = 4)

① Gum for AMP 07/23/12 C

Toxstat Version 3.5
Study # ~~60225262~~-445-(035-038)
ESTCP ① 60147216
Echinochloa ~~crusgalii~~ crusgalli ①
Kruskal-Wallis Comparison for Plant Nutrient: Sulfur(mg/kg)

4/27/12
QA: cw 04/30/12

Title: 60147216-445-Sulfur
File: 445nutsu.dat Transform: NO TRANSFORMATION

Kruskal - Wallis' ANOVA by Ranks - TABLE 1 OF 2

GROUP	IDENTIFICATION	TRANSFORMED MEAN	MEAN CALCULATED IN ORIGINAL UNITS	RANK SUM
1	Control	4247.5000	4247.5000	10.0000
2	APG-02	19000.0000	19000.0000	37.0000
3	APG-06	20875.0000	20875.0000	48.5000
4	APG-15	32125.0000	32125.0000	70.0000
5	APG-16	19025.0000	19025.0000	44.5000

H Value = 13.4494 Critical H = 9.4877 (alpha = 0.05 , df = 4)
(p-value 0.0093)
Since Calc H > Crit H REJECT Ho:All groups are equal at alpha = 0.05

Title: 60147216-445-Sulfur
File: 445nutsu.dat Transform: NO TRANSFORMATION

Dunn's Multiple Comparison - Kruskal - Wallis - TABLE 2 OF 2

GROUP	IDENTIFICATION	TRANSFORMED MEAN	ORIGINAL MEAN	GROUP 0 1	0 2	0 5	0 3	0 4
1	Control	4247.5000	4247.5000	\				
2	APG-02	19000.0000	19000.0000	.	\			
5	APG-16	19025.0000	19025.0000	.	.	\		
3	APG-06	20875.0000	20875.0000	.	.	.	\	
4	APG-15	32125.0000	32125.0000	*	.	.	.	\

* = significant difference (alpha = 0.05) . = no significant difference
Table q value = 2.8070 (0.05, 5) SE = 4.1817

① GNM for ANP 07/23/12 C

Toxstat Version 3.5
Study # 60147216-445-(035-038)
ESTCP
Echinochloa ~~*erusgalii*~~ crusgalli ①
Summary Statistics for Plant Nutrient: Zinc(mg/kg)

QA: cw 04/30/12
dk 4/26/12

Title: 60147216-445-Zinc
File: 445nutZn.dat Transform: NO TRANSFORMATION

Summary Statistics on Data TABLE 1 of 2

GRP	IDENTIFICATION	N	MIN	MAX	MEAN
1	Control	4	25.0000	38.7000	33.0000
2	APG-02	4	345.0000	1870.0000	771.2500
3	APG-06	4	162.0000	392.0000	300.7500
4	APG-15	4	287.0000	809.0000	600.2500
5	APG-16	4	448.0000	1200.0000	872.7500

Title: 60147216-445-Zinc
File: 445nutZn.dat Transform: NO TRANSFORMATION

Summary Statistics on Data TABLE 2 of 2

GRP	IDENTIFICATION	VARIANCE	SD	SEM	C.V. %
1	Control	33.1800	5.7602	2.8801	17.4552
2	APG-02	538356.9167	733.7281	366.8640	95.1349
3	APG-06	9570.2500	97.8277	48.9138	32.5279
4	APG-15	59058.2500	243.0190	121.5095	40.4863
5	APG-16	99623.5833	315.6320	157.8160	36.1652

① own for ANP 07/23/12 C

Toxstat Version 3.5
Study # ~~60225262~~-445-(035-038)
ESTCP (1) 60147216
Echinochloa ~~*crusgalii*~~ crusgalli (1)
Determination of NOEC and LOEC for Plant Nutrient: Zinc (mg/kg)

QA:CW 04/30/12
4/27/12

Title: 60147216-445-Zinc
File: 445nutzn.dat Transform: NO TRANSFORMATION

Shapiro - Wilk's Test for Normality

D = 2119926.5400
W = 0.8265

Critical W = 0.8680 (alpha = 0.01 , N = 20)
W = 0.9050 (alpha = 0.05 , N = 20)

Data FAIL normality test (alpha = 0.01). Try another transformation.

Warning - The first three homogeneity tests are sensitive to non-normality and should not be performed with this data as is.

Title: 60147216-445-Zinc
File: 445nutzn.dat Transform: NO TRANSFORMATION

Bartlett's Test for Homogeneity of Variance

Calculated B1 statistic = 28.9433 (p-value = 0.0000)

Data FAIL B1 homogeneity test at 0.01 level. Try another transformation.

Critical B = 13.2767 (alpha = 0.01, df = 4)
= 9.4877 (alpha = 0.05, df = 4)

(1) [illegible] ANP 07/23/12 C

Toxstat Version 3.5
Study # ~~60225262~~ 60147216-445-(035-038)
ESTCP (1)
Echinochloa ~~*crusgalii*~~ crusgalli (1)
Kruskal-Wallis Comparison for Plant Nutrient: Zinc (mg/kg)

QA: cw 04/30/12
4/27/12

Title: 60147216-445-Zinc
File: 445nutzn.dat Transform: NO TRANSFORMATION

Kruskal - Wallis' ANOVA by Ranks - TABLE 1 OF 2

GROUP	IDENTIFICATION	TRANSFORMED MEAN	MEAN CALCULATED IN ORIGINAL UNITS	RANK SUM
1	Control	33.0000	33.0000	10.0000
2	APG-02	771.2500	771.2500	52.0000
3	APG-06	300.7500	300.7500	30.0000
4	APG-15	600.2500	600.2500	51.0000
5	APG-16	872.7500	872.7500	67.0000

H Value = 14.1000 Critical H = 9.4877 (alpha = 0.05 , df = 4)
(p-value 0.0070)
Since Calc H > Crit H REJECT Ho:All groups are equal at alpha = 0.05

Title: 60147216-445-Zinc
File: 445nutzn.dat Transform: NO TRANSFORMATION

Dunn's Multiple Comparison - Kruskal - Wallis - TABLE 2 OF 2

GROUP	IDENTIFICATION	TRANSFORMED MEAN	ORIGINAL MEAN	GROUP 0 1	0 3	0 4	0 2	0 5
1	Control	33.0000	33.0000	\				
3	APG-06	300.7500	300.7500	.	\			
4	APG-15	600.2500	600.2500	.	.	\		
2	APG-02	771.2500	771.2500	.	.	.	\	
5	APG-16	872.7500	872.7500	*	.	.	.	\

* = significant difference (alpha = 0.05) . = no significant difference
Table q value = 2.8070 (0.05, 5) SE = 4.1833

(1) Comment ANP 07/23/12 C

Toxstat Version 3.5
Study # 60147216-445-(035-038)
ESTCP
Echinochloa ~~crusgalii~~ crusgalli ①
Summary Statistics for Plant Nutrient: Nitrogen (%)

QA: cw 04/30/12
AR 4/26/12

Title: 60147216-445-Nitrogen
File: 445nutN.dat Transform: NO TRANSFORMATION

Summary Statistics on Data TABLE 1 of 2

GRP	IDENTIFICATION	N	MIN	MAX	MEAN
1	Control	4	0.8300	1.0500	0.9325
2	APG-02	4	0.8100	0.9700	0.8775
3	APG-06	4	0.7500	0.8200	0.7850
4	APG-15	4	0.6700	0.7700	0.7300
5	APG-16	4	0.6900	0.8100	0.7650

Title: 60147216-445-Nitrogen
File: 445nutN.dat Transform: NO TRANSFORMATION

Summary Statistics on Data TABLE 2 of 2

GRP	IDENTIFICATION	VARIANCE	SD	SEM	C.V. %
1	Control	0.0082	0.0903	0.0452	9.6862
2	APG-02	0.0053	0.0727	0.0364	8.2899
3	APG-06	0.0008	0.0289	0.0144	3.6774
4	APG-15	0.0018	0.0424	0.0212	5.8118
5	APG-16	0.0028	0.0526	0.0263	6.8757

① Gram for AMP 07/23/12 C

Toxstat Version 3.5
Study # ~~60225262~~-445-(035-038)
ESTCP ① 60147216
Echinochloa ~~*crusgalii*~~ crusgalli ①
Determination of NOEC and LOEC for Plant Nutrient: Nitrogen (mg/kg)

QA: CW 04/30/12
4/27/12

Title: 60147216-445-Nitrogen
File: 445nutn.dat Transform: NO TRANSFORMATION

Shapiro - Wilk's Test for Normality

D = 0.0566
W = 0.9740

Critical W = 0.8680 (alpha = 0.01 , N = 20)
W = 0.9050 (alpha = 0.05 , N = 20)

Data PASS normality test (alpha = 0.01). Continue analysis.

Title: 60147216-445-Nitrogen
File: 445nutn.dat Transform: NO TRANSFORMATION

Bartlett's Test for Homogeneity of Variance

Calculated B1 statistic = 3.8305 (p-value = 0.4294)

Data PASS B1 homogeneity test at 0.01 level. Continue analysis.

Critical B = 13.2767 (alpha = 0.01, df = 4)
= 9.4877 (alpha = 0.05, df = 4)

① GWM for ANP 07/23/12 C

Toxstat Version 3.5
Study # 60147216-445-(035-038)
ESTCP
Echinochloa ~~*grusgalli*~~ crusgalli ①
Tukey Comparison for Plant Nutrient: Nitrogen (%)

QA: CW 04/30/12
4/26/12

Title: 60147216-445-Nitrogen
File: 445nutN.dat Transform: NO TRANSFORMATION

ANOVA Table

SOURCE	DF	SS	MS	F
Between	4	0.1132	0.0283	7.5046
Within (Error)	15	0.0566	0.0038	
Total	19	0.1697		

(p-value = 0.0016)

Critical F = 4.8932 (alpha = 0.01, df = 4,15)
= 3.0556 (alpha = 0.05, df = 4,15)

Since F > Critical F REJECT Ho: All equal (alpha = 0.05)

Title: 60147216-445-Nitrogen
File: 445nutN.dat Transform: NO TRANSFORMATION

Tukey Method of Multiple Comparisons

GROUP	IDENTIFICATION	TRANSFORMED MEAN	ORIGINAL MEAN	GROUP 0 4	0 5	0 3	0 2	0 1
4	APG-15	0.7300	0.7300	\				
5	APG-16	0.7650	0.7650	.	\			
3	APG-06	0.7850	0.7850	.	.	\		
2	APG-02	0.8775	0.8775	*	.	.	\	
1	Control	0.9325	0.9325	*	*	*	.	\

* = significant difference (alpha = 0.05) . = no significant difference

Tukey critical value = 4.3670 (df = 5,15) s = 0.0038

① Corrected for ANP 07/23/12 C

Toxstat Version 3.5
Study # 60147216-445-(035-038)
ESTCP
Echinochloa crusgalli
Summary statistics for Plant Nutrient: Nitrogen (mg/Kg)

ck 5/21/12
QA: GLM 07/18/12

Title: 60147216-445-Nitrogen
File: 445nutN.dat   Transform: NO TRANSFORMATION

Summary Statistics on Data   TABLE 1 of 2

GRP	IDENTIFICATION	N	MIN	MAX	MEAN
1	Control	4	8300.0000	10500.0000	9325.0000
2	APG-02	4	8100.0000	9700.0000	8775.0000
3	APG-06	4	7500.0000	8200.0000	7850.0000
4	APG-15	4	6700.0000	7700.0000	7300.0000
5	APG-16	4	6900.0000	8100.0000	7650.0000

Title: 60147216-445-Nitrogen
File: 445nutN.dat   Transform: NO TRANSFORMATION

Summary Statistics on Data   TABLE 2 of 2

GRP	IDENTIFICATION	VARIANCE	SD	SEM	C.V. %
1	Control	815833.3333	903.2349	451.6175	9.6862
2	APG-02	529166.6667	727.4384	363.7192	8.2899
3	APG-06	83333.3333	288.6751	144.3376	3.6774
4	APG-15	180000.0000	424.2641	212.1320	5.8118
5	APG-16	276666.6667	525.9911	262.9956	6.8757

Toxstat Version 3.5
Study # 60147216-445-(035-038)
ESTCP
Echinochloa crusgalli
Determination of NOEC and LOEC for Plant Nutrient: Nitrogen (mg/Kg)

QA: GLM 07/18/12
dk 5/21/12

```
Title:  60147216-445-Nitrogen
File:        445nutN.dat             Transform:              NO TRANSFORMATION

                  Shapiro - Wilk's Test for Normality
-----------------------------------------------------------------------------

     D = 5655000.0000
     W =    0.9740

     Critical W  = 0.8680 (alpha = 0.01 , N = 20)
              W  = 0.9050 (alpha = 0.05 , N = 20)

-----------------------------------------------------------------------------

Data PASS normality test (alpha = 0.01). Continue analysis.


Title:  60147216-445-Nitrogen
File:        445nutN.dat             Transform:              NO TRANSFORMATION

               Bartlett's Test for Homogeneity of Variance
-----------------------------------------------------------------------------

Calculated B1 statistic =  3.8305               (p-value = 0.4294)

Data PASS B1 homogeneity test at 0.01 level. Continue analysis.

-----------------------------------------------------------------------------

Critical B = 13.2767  (alpha = 0.01, df =  4)
           =  9.4877  (alpha = 0.05, df =  4)
```

Toxstat Version 3.5
Study # 60147216-445-(035-038)
ESTCP
Echinochloa crusgalli
Tukeu Comparison Test for Plant Nutrient: Nitrogen (mg/Kg)

QA: GNM 07/18/12
AP 5/21/12.

Title: 60147216-445-Nitrogen
File: 445nutN.dat Transform: NO TRANSFORMATION

ANOVA Table

SOURCE	DF	SS	MS	F
Between	4	11317000.0000	2829250.0000	7.5046
Within (Error)	15	5655000.0000	377000.0000	
Total	19	16972000.0000		

(p-value = 0.0016)

Critical F = 4.8932 (alpha = 0.01, df = 4,15)
= 3.0556 (alpha = 0.05, df = 4,15)

Since F > Critical F REJECT Ho: All equal (alpha = 0.05)

Title: 60147216-445-Nitrogen
File: 445nutN.dat Transform: NO TRANSFORMATION

Tukey Method of Multiple Comparisons

GROUP	IDENTIFICATION	TRANSFORMED MEAN	ORIGINAL MEAN	GROUP 0 4	0 5	0 3	0 2	0 1
4	APG-15	7300.0000	7300.0000	\				
5	APG-16	7650.0000	7650.0000	.	\			
3	APG-06	7850.0000	7850.0000	.	.	\		
2	APG-02	8775.0000	8775.0000	*	.	.	\	
1	Control	9325.0000	9325.0000	*	*	*	.	\

* = significant difference (alpha = 0.05) . = no significant difference

Tukey critical value = 4.3670 (df = 5,15) s = 377000.0000

-no control data,
N (w/w), avg pH

08

Statistix 8.0 Echinochloa-minus co..., 5/3/2012, 3:51:33 PM

Stepwise Linear Regression of DryWt "start indep. variables"
Unforced Variables: CaSoil CuSoil FeSoil KSoil MgSoil MnSoil NSoil NaSoil PSoil SSoil ZnSoil BSoil pHSoil TOCSoil
Variable(s) dropped from initial model because of collinearity: KSoil MgSoil MnSoil NSoil NaSoil PSoil SSoil ZnSoil BSoil pHSoil TOCSoil
P to Enter 0.0500
P to Exit 0.0500

Step	R Sq	MSE	P	CASOIL	CUSOIL	FESOIL	KSOIL	MGSOIL	MNSOIL	NSOIL	NASOIL	PSOIL	SSOIL	ZNSOIL	BSOIL	PHSOIL	TOCSOIL
1	0.7996	6.839E-05		A	B	C	.	.	.	.	.	.	.	.	.	.	.
2	0.7633	7.453E-05	0.1666 -	.	B	C	.	.	.	.	.	.	.	.	.	.	.

Resulting Stepwise Model

Variable	Coefficient	Std Error	T	P	VIF
Constant	-0.01233	0.01198	-1.03	0.3221	
CuSoil	-3.140E-05	9.644E-06	-3.26	0.0063	1.8
FeSoil	5.207E-06	8.189E-07	6.36	0.0000	1.8

Cases Included	16	R Squared	0.7633	MSE	7.453E-05
Missing Cases	0	Adj R Sq	0.7269	SD	0.00863

Variables Not in the Model

Variable	Correlations Multiple	Correlations Partial	T	P
CaSoil	0.9541	0.3912	1.47	0.1666
KSoil	0.9677	0.3912	1.47	0.1666
MgSoil	0.7083	0.3912	1.47	0.1666
MnSoil	0.9576	0.3912	1.47	0.1666
NSoil	0.1948	-0.3912	-1.47	0.1666
NaSoil	0.9909	0.3912	1.47	0.1666
PSoil	0.9348	-0.3912	-1.47	0.1666
SSoil	0.9747	0.3912	1.47	0.1666
ZnSoil	0.9705	0.3912	1.47	0.1666
BSoil	0.8684	0.3912	1.47	0.1666
pHSoil	0.5316	0.3912	1.47	0.1666
TOCSoil	0.7430	-0.3912	-1.47	0.1666

-no control data
- N (w/w), avg pH

Page 53 of 65

08

QA BN 7/2/12

Statistix 8.0 Echinochloa-minus co..., 5/3/2012, 3:52:31 PM

Stepwise Linear Regression of Length " Start - indep. Variables"

Unforced Variables: CaSoil CuSoil FeSoil KSoil MgSoil MnSoil NSoil NaSoil PSoil SSoil ZnSoil BSoil pHSoil TOCSoil

Variable(s) dropped from initial model because of collinearity: KSoil MgSoil MnSoil NSoil NaSoil PSoil SSoil ZnSoil BSoil pHSoil TOCSoil

P to Enter 0.0500

P to Exit 0.0500

Step	R Sq	MSE	P	CASOIL	CUSOIL	FESOIL	KSOIL	MGSOIL	MNSOIL	NSOIL	NASOIL	PSOIL	SSOIL	ZNSOIL	BSOIL	PHSOIL	TOCSOIL
1	0.5725	327.662		A	B	C	.	.	.	.	.	.	.	.	.	.	.
2	0.5648	307.883	0.6510 -	.	B	C	.	.	.	.	.	.	.	.	.	.	.

Resulting Stepwise Model

Variable	**Coefficient**	**Std Error**	**T**	**P**	**VIF**
Constant	140.102	24.3439	5.76	0.0001	
CuSoil	-0.05482	0.01960	-2.80	0.0151	1.8
FeSoil	0.00683	0.00166	4.11	0.0012	1.8

Cases Included	16	R Squared	0.5648	MSE	307.883
Missing Cases	0	Adj R Sq	0.4979	SD	17.5466

Variables Not in the Model

Variable	**Correlations Multiple**	**Partial**	**T**	**P**
CaSoil	0.9541	0.1327	0.46	0.6510
KSoil	0.9677	0.1327	0.46	0.6510
MgSoil	0.7083	0.1327	0.46	0.6510
MnSoil	0.9576	0.1327	0.46	0.6510
NSoil	0.1948	-0.1327	-0.46	0.6510
NaSoil	0.9909	0.1327	0.46	0.6510
PSoil	0.9348	-0.1327	-0.46	0.6510
SSoil	0.9747	0.1327	0.46	0.6510
ZnSoil	0.9705	0.1327	0.46	0.6510
BSoil	0.8684	0.1327	0.46	0.6510
pHSoil	0.5316	0.1327	0.46	0.6510
TOCSoil	0.7430	-0.1327	-0.46	0.6510

-no control data
- N(w/w), avg pH

QA 4/8/12

Statistix 8.0 Echinochloa-minus co..., 5/3/2012, 3:52:49 PM

Stepwise Linear Regression of BPlant "start. indep. variables"

Unforced Variables: CaSoil CuSoil FeSoil KSoil MgSoil MnSoil NSoil NaSoil PSoil SSoil ZnSoil BSoil pHSoil TOCSoil

Variable(s) dropped from initial model because of collinearity: KSoil MgSoil MnSoil NSoil NaSoil PSoil SSoil ZnSoil BSoil pHSoil TOCSoil

P to Enter 0.0500
P to Exit 0.0500

Step	R Sq	MSE	P	CASOIL	CUSOIL	FESOIL	KSOIL	MGSOIL	MNSOIL	NSOIL	NASOIL	PSOIL	SSOIL	ZNSOIL	BSOIL	PHSOIL	TOCSOIL
1	0.6674	11.1329		A	B	C	.	.	.	.	.	.	.	.	.	.	.

Resulting Stepwise Model

Variable	Coefficient	Std Error	T	P	VIF
Constant	38.7015	6.36501	6.08	0.0001	
CaSoil	-0.00101	2.550E-04	-3.97	0.0019	11.2
CuSoil	0.04012	0.01172	3.42	0.0051	17.4
FeSoil	-0.00181	4.726E-04	-3.84	0.0024	3.9

Cases Included	16	R Squared	0.6674	MSE	11.1329
Missing Cases	0	Adj R Sq	0.5842	SD	3.33660

Variables Not in the Model

Variable	Correlations Multiple	Partial	T	P
KSoil	1.0000	-0.0000	-0.00	1.0000
MgSoil	1.0000	M	M	M
MnSoil	1.0000	M	M	M
NSoil	1.0000	M	M	M
NaSoil	1.0000	0.0000	0.00	1.0000
PSoil	1.0000	-0.0000	-0.00	1.0000
SSoil	1.0000	0.0000	0.00	1.0000
ZnSoil	1.0000	-0.0000	-0.00	1.0000
BSoil	1.0000	M	M	M
pHSoil	1.0000	M	M	M
TOCSoil	1.0000	M	M	M

-no control data
- N (w/w), avg pH

Page 55 of 65
QA [initials] 7/2/12

08

Stepwise Linear Regression of CaPlant

"Start indep. variables"

Unforced Variables: CaSoil CuSoil FeSoil KSoil MgSoil MnSoil NSoil NaSoil PSoil SSoil ZnSoil BSoil pHSoil TOCSoil
Variable(s) dropped from initial model because of collinearity: KSoil MgSoil MnSoil NSoil NaSoil PSoil SSoil ZnSoil BSoil pHSoil TOCSoil
P to Enter 0.0500
P to Exit 0.0500

Step	R Sq	MSE	P		CASOIL	CUSOIL	FESOIL	KSOIL	MGSOIL	MNSOIL	NSOIL	NASOIL	PSOIL	SSOIL	ZNSOIL	BSOIL	PHSOIL	TOCSOIL
1	0.5994	6.048E+07			A	B	C	.	.	.	.	.	.	.	.	.	.	.
2	0.5987	5.592E+07	0.8865	-	A	.	C	.	.	.	.	.	.	.	.	.	.	.
3	0.5792	5.445E+07	0.4407	-	A	.	.	.	.	.	.	.	.	.	.	.	.	.

Resulting Stepwise Model

Variable	Coefficient	Std Error	T	P	VIF
Constant	10296.2	2603.12	3.96	0.0014	
CaSoil	0.74115	0.16884	4.39	0.0006	1.0

Cases Included	16	R Squared	0.5792	MSE	5.445E+07
Missing Cases	0	Adj R Sq	0.5491	SD	7379.32

Variables Not in the Model

Variable	Correlations Multiple	Correlations Partial	T	P
CuSoil	0.8945	0.1598	0.58	0.5695
FeSoil	0.3370	0.2154	0.80	0.4407
KSoil	0.4535	0.2189	0.81	0.4332
MgSoil	0.8812	-0.0270	-0.10	0.9238
MnSoil	0.8455	0.2193	0.81	0.4323
NSoil	0.1194	-0.0016	-0.01	0.9954
NaSoil	0.3078	0.2192	0.81	0.4325
PSoil	0.7054	0.1056	0.38	0.7080
SSoil	0.2810	0.2186	0.81	0.4337
ZnSoil	0.5912	0.2193	0.81	0.4323
BSoil	0.4334	0.2049	0.75	0.4638
pHSoil	0.7535	0.0463	0.17	0.8697
TOCSoil	0.4915	0.0243	0.09	0.9316

-no control data
- N(w/w), avg pH

QA 13N 7/2/12

Statistix 8.0 Echinochloa-minus co..., 5/3/2012, 3:53:12 PM

Stepwise Linear Regression of CuPlant "start. indep. variables"
Unforced Variables: CaSoil CuSoil FeSoil KSoil MgSoil MnSoil NSoil NaSoil PSoil SSoil ZnSoil BSoil pHSoil TOCSoil
Variable(s) dropped from initial model because of collinearity: KSoil MgSoil MnSoil NSoil NaSoil PSoil SSoil ZnSoil BSoil pHSoil TOCSoil
P to Enter 0.0500
P to Exit 0.0500

Step	R Sq	MSE	P	CASOIL	CUSOIL	FESOIL	KSOIL	MGSOIL	MNSOIL	NSOIL	NASOIL	PSOIL	SSOIL	ZNSOIL	BSOIL	PHSOIL	TOCSOIL
1	0.6319	21.8162		A	B	C	.	.	.	.	.	.	.	.	.	.	.

Resulting Stepwise Model

Variable	Coefficient	Std Error	T	P	VIF
Constant	44.1818	8.91014	4.96	0.0003	
CaSoil	-0.00146	3.570E-04	-4.09	0.0015	11.2
CuSoil	0.07391	0.01641	4.50	0.0007	17.4
FeSoil	-0.00260	6.616E-04	-3.93	0.0020	3.9

Cases Included	16	R Squared	0.6319	MSE	21.8162
Missing Cases	0	Adj R Sq	0.5399	SD	4.67079

Variables Not in the Model

	Correlations			
Variable	**Multiple**	**Partial**	**T**	**P**
KSoil	1.0000	0.0000	0.00	1.0000
MgSoil	1.0000	M	M	M
MnSoil	1.0000	M	M	M
NSoil	1.0000	M	M	M
NaSoil	1.0000	0.0000	0.00	1.0000
PSoil	1.0000	-0.0000	-0.00	1.0000
SSoil	1.0000	0.0000	0.00	1.0000
ZnSoil	1.0000	-0.0000	-0.00	1.0000
BSoil	1.0000	M	M	M
pHSoil	1.0000	M	M	M
TOCSoil	1.0000	M	M	M

-no control data
- N(w/w), avg pH

AS QA 6/4/12

Statistix 8.0 Echinochloa-minus co..., 5/3/2012, 3:53:23 PM

Stepwise ~~Linear~~ Regression of FePlant "start. indep. variables"

Unforced Variables: CaSoil CuSoil FeSoil KSoil MgSoil MnSoil NSoil NaSoil PSoil SSoil ZnSoil BSoil pHSoil TOCSoil

Variable(s) dropped from initial model because of collinearity: KSoil MgSoil MnSoil NSoil NaSoil PSoil SSoil ZnSoil BSoil pHSoil TOCSoil

P to Enter 0.0500
P to Exit 0.0500

Step	R Sq	MSE	P		CASOIL	CUSOIL	FESOIL	KSOIL	MGSOIL	MNSOIL	NSOIL	NASOIL	PSOIL	SSOIL	ZNSOIL	BSOIL	PHSOIL	TOCSOIL
1	0.3205	9139.54			A	B	C	.	.	.	.	.	.	.	.	.	.	.
2	0.2071	9845.39	0.1823	-	A	.	C	.	.	.	.	.	.	.	.	.	.	.
3	0.1716	9550.64	0.4596	-	.	.	C	.	.	.	.	.	.	.	.	.	.	.
4	0.0000	10761.0	0.1106	-	.	.	.	.	.	.	.	.	.	.	.	.	.	.
5	0.2994	8077.54	0.0283	+	.	.	.	.	.	.	.	.	.	.	.	L	.	.

Resulting Stepwise Model

Variable	Coefficient	Std Error	T	P	VIF
Constant	479.619	131.880	3.64	0.0027	
BSoil	-64.2159	26.2528	-2.45	0.0283	1.0

Cases Included	16	R Squared	0.2994	MSE	8077.54
Missing Cases	0	Adj R Sq	0.2494	SD	89.8751

Variables Not in the Model

	Correlations			
Variable	Multiple	Partial	T	P
CaSoil	0.4334	-0.1056	-0.38	0.7079
CuSoil	0.5638	-0.0252	-0.09	0.9291
FeSoil	0.8684	0.1466	0.53	0.6021
KSoil	0.9633	0.1206	0.44	0.6687
MgSoil	0.4833	-0.1622	-0.59	0.5635
MnSoil	0.8149	-0.0535	-0.19	0.8497
NSoil	0.3764	0.1321	0.48	0.6388
NaSoil	0.9254	0.1614	0.59	0.5654
PSoil	0.3939	0.0371	0.13	0.8956
SSoil	0.9513	0.1714	0.63	0.5413
ZnSoil	0.9374	0.0491	0.18	0.8619
pHSoil	0.6497	-0.1727	-0.63	0.5382
TOCSoil	0.0165	0.0595	0.21	0.8333

-no control data
-N (w/w), avg pH

6/6/12

Statistix 8.0 Echinochloa-minus co..., 5/3/2012, 3:53:37 PM

Stepwise Linear Regression of KPlant "starting indep. variables"

Unforced Variables: CaSoil CuSoil FeSoil KSoil MgSoil MnSoil NSoil NaSoil PSoil SSoil ZnSoil BSoil pHSoil TOCSoil

Variable(s) dropped from initial model because of collinearity: KSoil MgSoil MnSoil NSoil NaSoil PSoil SSoil ZnSoil BSoil pHSoil TOCSoil

P to Enter 0.0500

P to Exit 0.0500

Step	R Sq	MSE	P		CASOIL	CUSOIL	FESOIL	KSOIL	MGSOIL	MNSOIL	NSOIL	NASOIL	PSOIL	SSOIL	ZNSOIL	BSOIL	PHSOIL	TOCSOIL
1	0.1118	4511042			A	B	C	.	.	.	.	.	.	.	.	.	.	.
2	0.1117	4164640	0.9675	-	A	B	.	.	.	.	.	.	.	.	.	.	.	.
3	0.0283	4230252	0.2893	-	.	B	.	.	.	.	.	.	.	.	.	.	.	.
4	0.0000	4063292	0.5333	-	.	.	.	.	.	.	.	.	.	.	.	.	.	.

Resulting Stepwise Model

Variable	Coefficient	Std Error	T	P	VIF
Constant	16893.8	503.940	33.52	0.0000	

Cases Included	16	R Squared	0.0000	MSE	4063292
Missing Cases	0	Adj R Sq	0.0000	SD	2015.76

Variables Not in the Model

Variable	Correlations Multiple	Correlations Partial	T	P
CaSoil	0.0000	-0.0214	-0.08	0.9373
CuSoil	0.0000	-0.1683	-0.64	0.5333
FeSoil	0.0000	-0.2780	-1.08	0.2972
KSoil	0.0000	-0.2208	-0.85	0.4113
MgSoil	0.0000	0.0990	0.37	0.7151
MnSoil	0.0000	-0.1528	-0.58	0.5720
NSoil	0.0000	-0.2142	-0.82	0.4256
NaSoil	0.0000	-0.2513	-0.97	0.3479
PSoil	0.0000	-0.2375	-0.91	0.3758
SSoil	0.0000	-0.2298	-0.88	0.3919
ZnSoil	0.0000	-0.2136	-0.82	0.4270
BSoil	0.0000	-0.1498	-0.57	0.5796
pHSoil	0.0000	0.0905	0.34	0.7388
TOCSoil	0.0000	-0.2253	-0.87	0.4015

- no control data
- N(w/w), avg pH

Page 59 of 65

QA [illegible] 6/8/12
AS

Stepwise Linear Regression of MgPlant "Start. indep. variables"

Unforced Variables: CaSoil CuSoil FeSoil KSoil MgSoil MnSoil NSoil NaSoil PSoil SSoil ZnSoil BSoil pHSoil TOCSoil

Variable(s) dropped from initial model because of collinearity: KSoil MgSoil MnSoil NSoil NaSoil PSoil SSoil ZnSoil BSoil pHSoil TOCSoil

P to Enter 0.0500
P to Exit 0.0500

Step	R Sq	MSE	P	CASOIL	CUSOIL	FESOIL	KSOIL	MGSOIL	MNSOIL	NSOIL	NASOIL	PSOIL	SSOIL	ZNSOIL	BSOIL	PHSOIL	TOCSOIL
1	0.8191	1250565		A	B	C	.	.	.	.	.	.	.	.	.	.	.
2	0.8077	1227058	0.4017 -	A	.	C	.	.	.	.	.	.	.	.	.	.	.
3	0.8017	1174979	0.5352 -	.	.	C	.	.	.	.	.	.	.	.	.	.	.

Resulting Stepwise Model

Variable	Coefficient	Std Error	T	P	VIF
Constant	21005.2	1345.69	15.61	0.0000	
FeSoil	-0.58336	0.07754	-7.52	0.0000	1.0

Cases Included	16	R Squared	0.8017	MSE	1174979
Missing Cases	0	Adj R Sq	0.7875	SD	1083.96

Variables Not in the Model

Variable	Correlations Multiple	Correlations Partial	T	P
CaSoil	0.3370	0.1740	0.64	0.5352
CuSoil	0.6567	0.0887	0.32	0.7531
KSoil	0.9659	0.2953	1.11	0.2852
MgSoil	0.1604	0.2641	0.99	0.3415
MnSoil	0.7794	0.2088	0.77	0.4553
NSoil	0.1280	-0.2663	-1.00	0.3374
NaSoil	0.9882	0.2055	0.76	0.4625
PSoil	0.6629	-0.0559	-0.20	0.8431
SSoil	0.9667	0.2032	0.75	0.4676
ZnSoil	0.9441	0.2671	1.00	0.3359
BSoil	0.8684	0.2810	1.06	0.3104
pHSoil	0.2691	0.2907	1.10	0.2931
TOCSoil	0.4074	-0.1467	-0.53	0.6018

-no control data
- N(w/w), avg pH

Page 40 of 65
QA BJW 6/8/12
AB

"Start. indep. variables"

Stepwise Linear Regression of MnPlant
Unforced Variables: CaSoil CuSoil FeSoil KSoil MgSoil MnSoil NSoil NaSoil PSoil SSoil ZnSoil BSoil pHSoil TOCSoil
Variable(s) dropped from initial model because of collinearity: KSoil MgSoil MnSoil NSoil NaSoil PSoil SSoil ZnSoil BSoil pHSoil TOCSoil
P to Enter 0.0500
P to Exit 0.0500

Step	R Sq	MSE	P	CASOIL	CUSOIL	FESOIL	KSOIL	MGSOIL	MNSOIL	NSOIL	NASOIL	PSOIL	SSOIL	ZNSOIL	BSOIL	PHSOIL	TOCSOIL
1	0.7833	114312		A	B	C	.	.	.	.	.	.	.	.	.	.	.

Resulting Stepwise Model

Variable	Coefficient	Std Error	T	P	VIF
Constant	4246.90	644.970	6.58	0.0000	
CaSoil	-0.15937	0.02584	-6.17	0.0000	11.2
CuSoil	6.65733	1.18778	5.60	0.0001	17.4
FeSoil	-0.25605	0.04789	-5.35	0.0002	3.9

Cases Included	16	R Squared	0.7833	MSE	114312
Missing Cases	0	Adj R Sq	0.7292	SD	338.100

Variables Not in the Model

	Correlations			
Variable	**Multiple**	**Partial**	**T**	**P**
KSoil	1.0000	-0.0000	-0.00	1.0000
MgSoil	1.0000	M	M	M
MnSoil	1.0000	M	M	M
NSoil	1.0000	M	M	M
NaSoil	1.0000	0.0000	0.00	1.0000
PSoil	1.0000	-0.0000	-0.00	1.0000
SSoil	1.0000	0.0000	0.00	1.0000
ZnSoil	1.0000	-0.0000	-0.00	1.0000
BSoil	1.0000	M	M	M
pHSoil	1.0000	M	M	M
TOCSoil	1.0000	M	M	M

Statistix 8.0 Echinochloa-minus co..., 5/3/2012, 3:54:19 PM ASS

Stepwise Linear Regression of NPlant "Start. indep. variables"
Unforced Variables: CaSoil CuSoil FeSoil KSoil MgSoil MnSoil NSoil NaSoil PSoil SSoil ZnSoil BSoil pHSoil TOCSoil
Variable(s) dropped from initial model because of collinearity: KSoil MgSoil MnSoil NSoil NaSoil PSoil SSoil ZnSoil BSoil pHSoil TOCSoil
P to Enter 0.0500
P to Exit 0.0500

Step	R Sq	MSE	P	CASOIL	CUSOIL	FESOIL	KSOIL	MGSOIL	MNSOIL	NSOIL	NASOIL	PSOIL	SSOIL	ZNSOIL	BSOIL	PHSOIL	TOCSOIL
1	0.5975	267292		A	B	C	.	.	.	.	.	.	.	.	.	.	.

Resulting Stepwise Model

Variable	Coefficient	Std Error	T	P	VIF
Constant	11043.5	986.250	11.20	0.0000	
CaSoil	-0.12824	0.03951	-3.25	0.0070	11.2
CuSoil	4.74097	1.81629	2.61	0.0228	17.4
FeSoil	-0.21296	0.07324	-2.91	0.0131	3.9

Cases Included	16	R Squared	0.5975	MSE	267292
Missing Cases	0	Adj R Sq	0.4969	SD	517.003

Variables Not in the Model

Variable	Correlations Multiple	Correlations Partial	T	P
KSoil	1.0000	0.0000	0.00	1.0000
MgSoil	1.0000	M	M	M
MnSoil	1.0000	M	M	M
NSoil	1.0000	M	M	M
NaSoil	1.0000	0.0000	0.00	1.0000
PSoil	1.0000	-0.0000	-0.00	1.0000
SSoil	1.0000	0.0000	0.00	1.0000
ZnSoil	1.0000	-0.0000	-0.00	1.0000
BSoil	1.0000	M	M	M
pHSoil	1.0000	M	M	M
TOCSoil	1.0000	M	M	M

Statistix 8.0 Echinochloa-minus co..., 5/3/2012, 3:54:37 PM

Stepwise Linear Regression of NaPlant "Start. indep. variables"

Unforced Variables: CaSoil CuSoil FeSoil KSoil MgSoil MnSoil NSoil NaSoil PSoil SSoil ZnSoil BSoil pHSoil TOCSoil

Variable(s) dropped from initial model because of collinearity: KSoil MgSoil MnSoil NSoil NaSoil PSoil SSoil ZnSoil BSoil pHSoil TOCSoil

P to Enter 0.0500

P to Exit 0.0500

Step	R Sq	MSE	P	CASOIL	CUSOIL	FESOIL	KSOIL	MGSOIL	MNSOIL	NSOIL	NASOIL	PSOIL	SSOIL	ZNSOIL	BSOIL	PHSOIL	TOCSOIL
1	0.4046	5261492		A	B	C	.	.	.	.	.	.	.	.	.	.	.
2	0.4044	4858101	0.9551 -	A	.	C	.	.	.	.	.	.	.	.	.	.	.
3	0.3051	5263077	0.1648 -	.	.	C	.	.	.	.	.	.	.	.	.	.	.

Resulting Stepwise Model

Variable	Coefficient	Std Error	T	P	VIF
Constant	-2889.84	2848.08	-1.01	0.3275	
FeSoil	0.40688	0.16410	2.48	0.0265	1.0

Cases Included	16	R Squared	0.3051	MSE	5263077
Missing Cases	0	Adj R Sq	0.2555	SD	2294.14

Variables Not in the Model

Variable	Correlations Multiple	Correlations Partial	T	P
CaSoil	0.3370	0.3780	1.47	0.1648
CuSoil	0.6567	0.3535	1.36	0.1962
KSoil	0.9659	0.2117	0.78	0.4489
MgSoil	0.1604	0.3435	1.32	0.2101
MnSoil	0.7794	0.3759	1.46	0.1674
NSoil	0.1280	-0.0809	-0.29	0.7743
NaSoil	0.9882	-0.0511	-0.18	0.8565
PSoil	0.6629	0.2473	0.92	0.3743
SSoil	0.9667	-0.0551	-0.20	0.8454
ZnSoil	0.9441	0.3398	1.30	0.2153
BSoil	0.8684	0.1286	0.47	0.6478
pHSoil	0.2691	0.2868	1.08	0.3001
TOCSoil	0.4074	0.1417	0.52	0.6144

- no control data
- N(W/W), avg pH
A8 QA RZN 6/8/12

Stepwise Linear Regression of PPlant "start. indep. variables"
Unforced Variables: CaSoil CuSoil FeSoil KSoil MgSoil MnSoil NSoil NaSoil PSoil SSoil ZnSoil BSoil pHSoil TOCSoil
Variable(s) dropped from initial model because of collinearity: KSoil MgSoil MnSoil NSoil NaSoil PSoil SSoil ZnSoil BSoil pHSoil TOCSoil
P to Enter 0.0500
P to Exit 0.0500

Step	R Sq	MSE	P	CASOIL	CUSOIL	FESOIL	KSOIL	MGSOIL	MNSOIL	NSOIL	NASOIL	PSOIL	SSOIL	ZNSOIL	BSOIL	PHSOIL	TOCSOIL
1	0.4906	56954.2		A	B	C	.	.	.	.	.	.	.	.	.	.	.
2	0.3357	68559.7	0.0803 -	.	B	C	.	.	.	.	.	.	.	.	.	.	.
3	0.3316	64060.9	0.7800 -	.	.	C	.	.	.	.	.	.	.	.	.	.	.

Resulting Stepwise Model

Variable	Coefficient	Std Error	T	P	VIF
Constant	2827.37	314.216	9.00	0.0000	
FeSoil	-0.04771	0.01810	-2.64	0.0196	1.0

Cases Included	16	R Squared	0.3316	MSE	64060.9
Missing Cases	0	Adj R Sq	0.2838	SD	253.103

Variables Not in the Model

	Correlations			
Variable	Multiple	Partial	T	P
CaSoil	0.3370	-0.0783	-0.28	0.7815
CuSoil	0.6567	0.0788	0.29	0.7800
KSoil	0.9659	-0.4508	-1.82	0.0917
MgSoil	0.1604	-0.2892	-1.09	0.2959
MnSoil	0.7794	-0.1514	-0.55	0.5901
NSoil	0.1280	0.4878	2.01	0.0651
NaSoil	0.9882	-0.4603	-1.87	0.0842
PSoil	0.6629	0.2978	1.12	0.2811
SSoil	0.9667	-0.4586	-1.86	0.0856
ZnSoil	0.9441	-0.2980	-1.13	0.2807
BSoil	0.8684	-0.4827	-1.99	0.0684
pHSoil	0.2691	-0.3858	-1.51	0.1555
TOCSoil	0.4074	0.4064	1.60	0.1327

-no control data
- N(w/w), avg pH
Page 64 of 65
056 QA KBN 6/8/12

Stepwise Linear Regression of SPlant "Stapt. indep. variables"
Unforced Variables: CaSoil CuSoil FeSoil KSoil MgSoil MnSoil NSoil NaSoil PSoil SSoil ZnSoil BSoil pHSoil TOCSoil
Variable(s) dropped from initial model because of collinearity: KSoil MgSoil MnSoil NSoil NaSoil PSoil SSoil ZnSoil BSoil pHSoil TOCSoil
P to Enter 0.0500
P to Exit 0.0500

Step	R Sq	MSE	P		CASOIL	CUSOIL	FESOIL	KSOIL	MGSOIL	MNSOIL	NSOIL	NASOIL	PSOIL	SSOIL	ZNSOIL	BSOIL	PHSOIL	TOCSOIL
1	0.4426	5.009E+07			A	B	C	.	.	.	.	.	.	.	.	.	.	.
2	0.4416	4.633E+07	0.8832	-	A	.	C	.	.	.	.	.	.	.	.	.	.	.
3	0.4383	4.327E+07	0.7869	-	A	.	.	.	.	.	.	.	.	.	.	.	.	.

Resulting Stepwise Model

Variable	Coefficient	Std Error	T	P	VIF
Constant	17345.2	2320.41	7.48	0.0000	
CaSoil	0.49746	0.15050	3.31	0.0052	1.0

Cases Included	16	R Squared	0.4383	MSE	4.327E+07
Missing Cases	0	Adj R Sq	0.3982	SD	6577.88

Variables Not in the Model

Variable	Correlations Multiple	Correlations Partial	T	P
CuSoil	0.8945	-0.0413	-0.15	0.8838
FeSoil	0.3370	-0.0763	-0.28	0.7869
KSoil	0.4535	-0.0846	-0.31	0.7643
MgSoil	0.8812	-0.0176	-0.06	0.9503
MnSoil	0.8455	-0.0829	-0.30	0.7691
NSoil	0.1194	0.0287	0.10	0.9191
NaSoil	0.3078	-0.0822	-0.30	0.7709
PSoil	0.7054	-0.0154	-0.06	0.9566
SSoil	0.2810	-0.0850	-0.31	0.7634
ZnSoil	0.5912	-0.0833	-0.30	0.7680
BSoil	0.4334	-0.0876	-0.32	0.7562
pHSoil	0.7535	-0.0450	-0.16	0.8735
TOCSoil	0.4915	0.0187	0.07	0.9472

-no control data
- N(w/w), avg pH Page 65 of 65
~~08~~ DA BW 6/8/12

Stepwise Linear Regression of ZnPlant "start. indep. variables"
Unforced Variables: CaSoil CuSoil FeSoil KSoil MgSoil MnSoil NSoil NaSoil PSoil SSoil ZnSoil BSoil pHSoil TOCSoil
Variable(s) dropped from initial model because of collinearity: KSoil MgSoil MnSoil NSoil NaSoil PSoil SSoil ZnSoil BSoil pHSoil TOCSoil
P to Enter 0.0500
P to Exit 0.0500

Step	R Sq	MSE	P		CASOIL	CUSOIL	FESOIL	KSOIL	MGSOIL	MNSOIL	NASOIL	NSOIL	PSOIL	SSOIL	ZNSOIL	BSOIL	PHSOIL	TOCSOIL
1	0.2619	176652			A	B	C	.	.	.	.	.	.	.	.	.	.	.
2	0.2619	163065	0.9924	-	A	B	.	.	.	.	.	.	.	.	.	.	.	.
3	0.0194	201160	0.0593	-	.	B	.	.	.	.	.	.	.	.	.	.	.	.
4	-0.0000	191459	0.6071	-	.	.	.	.	.	.	.	.	.	.	.	.	.	.

Resulting Stepwise Model

Variable	Coefficient	Std Error	T	P	VIF
Constant	636.250	109.390	5.82	0.0000	

Cases Included	16	R Squared	-0.0000	MSE	191459
Missing Cases	0	Adj R Sq	-0.0000	SD	437.560

Variables Not in the Model

	Correlations			
Variable	**Multiple**	**Partial**	**T**	**P**
CaSoil	0.0000	-0.0957	-0.36	0.7245
CuSoil	0.0000	0.1392	0.53	0.6071
FeSoil	0.0000	0.3660	1.47	0.1632
KSoil	0.0000	0.2621	1.02	0.3268
MgSoil	0.0000	-0.2679	-1.04	0.3158
MnSoil	0.0000	0.1151	0.43	0.6712
NSoil	0.0000	0.3523	1.41	0.1808
NaSoil	0.0000	0.3270	1.29	0.2163
PSoil	0.0000	0.2720	1.06	0.3082
SSoil	0.0000	0.2966	1.16	0.2647
ZnSoil	0.0000	0.2355	0.91	0.3800
BSoil	0.0000	0.1546	0.59	0.5675
pHSoil	0.0000	-0.2438	-0.94	0.3629
TOCSoil	0.0000	0.2876	1.12	0.2800

Toxstat Version 3.5 Page_____of_____
Study # 60147216-445-(035-038)
ESTCP
Echinochloa crusgalli 12/13/12
Summary Statistics for Nutrient Uptake Factor: BORON USING Site Control GN:CW 12/13/12

Title: 60225262-445-(035-038)
File: 445boron.dat Transform: NO TRANSFORMATION

Summary Statistics on Data TABLE 1 of 2

GRP	IDENTIFICATION	N	MIN	MAX	MEAN
1	APG-15	4	1.2500	1.9500	1.6375
2	APG-02	4	4.0300	7.5000	5.1325
3	APG-06	4	2.5100	2.8900	2.6725
4	APG-16	4	1.2200	1.9800	1.6875

Title: 60225262-445-(035-038)
File: 445boron.dat Transform: NO TRANSFORMATION

Summary Statistics on Data TABLE 2 of 2

GRP	IDENTIFICATION	VARIANCE	SD	SEM	C.V. %
1	APG-15	0.0873	0.2955	0.1477	18.0428
2	APG-02	2.5408	1.5940	0.7970	31.0569
3	APG-06	0.0372	0.1929	0.0965	7.2194
4	APG-16	0.1225	0.3500	0.1750	20.7400

Toxstat Version 3.5 Page_____of_____
Study # 60147216-445-(035-038)
ESTCP
Echinochloa crusgalli
Analysis of Nutrient Uptake Factor: BORON USING Site Control

12/13/12
QA:cu 12/13/12

```
Title:   60225262-445-(035-038)
File:       445boron.dat            Transform:                LOG BASE 10(Y)

                   Shapiro - Wilk's Test for Normality
---------------------------------------------------------------------------

      D =    0.0954
      W =    0.9763

      Critical W  = 0.8440 (alpha = 0.01 , N = 16)
               W  = 0.8870 (alpha = 0.05 , N = 16)

---------------------------------------------------------------------------

Data PASS normality test (alpha = 0.01). Continue analysis.


Title:   60225262-445-(035-038)
File:       445boron.dat            Transform:                LOG BASE 10(Y)

                Bartlett's Test for Homogeneity of Variance
---------------------------------------------------------------------------

Calculated B1 statistic =  3.8940             (p-value = 0.2731)

Data PASS B1 homogeneity test at 0.01 level. Continue analysis.

---------------------------------------------------------------------------

Critical B = 11.3449  (alpha = 0.01, df =  3)
           =  7.8147  (alpha = 0.05, df =  3)
```

Toxstat Version 3.5 Page____of____
Study # 60147216-445-(035-038)
ESTCP
Echinochloa crusgalli
Analysis of Nutrient Uptake Factor: BORON USING Site Control

QA:CW 12\13\12
dk 12|13|12

Title: 60225262-445-(035-038)
File: 445boron.dat Transform: LOG BASE 10(Y)

ANOVA Table

SOURCE	DF	SS	MS	F
Between	3	0.6293	0.2098	26.4007
Within (Error)	12	0.0954	0.0079	
Total	15	0.7247		

(p-value = 0.0000)

Critical F = 5.9525 (alpha = 0.01, df = 3,12)
= 3.4903 (alpha = 0.05, df = 3,12)

Since F > Critical F REJECT Ho: All equal (alpha = 0.05)

Title: 60225262-445-(035-038)
File: 445boron.dat Transform: LOG BASE 10(Y)

Dunnett's Test - TABLE 1 OF 2 Ho:Control=Treatment

GROUP	IDENTIFICATION	TRANSFORMED MEAN	MEAN CALCULATED IN ORIGINAL UNITS	TRANS T STAT	SIG 0.05
1	APG-15	0.2085	1.6375		
2	APG-02	0.6967	5.1325	7.7448	*
3	APG-06	0.4261	2.6725	3.4514	*
4	APG-16	0.2195	1.6875	0.1745	

Dunnett critical value = 2.6800 (2 Tailed, alpha = 0.05, df = 3,12)

Title: 60225262-445-(035-038)
File: 445boron.dat Transform: LOG BASE 10(Y)

Dunnett's Test - TABLE 2 OF 2 Ho:Control=Treatment

GROUP	IDENTIFICATION	NUM OF REPS	MIN SIG DIFF (IN ORIG. UNITS)	% OF CONTROL	DIFFERENCE FROM CONTROL
1	APG-15	4			
2	APG-02	4	0.5208	32.2	3.4950
3	APG-06	4	0.5208	32.2	1.0350
4	APG-16	4	0.5208	32.2	0.0500

Toxstat Version 3.5 Page____of____
Study # 60147216-445-(035-038)
ESTCP
Echinochloa crusgalli
Summary Statistics for Nutrient Uptake Factor: CALCIUM using Site Control QA: CW 12/13/12
12/13/12

Title: 60225262-45-(035-038)
File: 445cal.dat Transform: NO TRANSFORMATION

Summary Statistics on Data TABLE 1 of 2

GRP	IDENTIFICATION	N	MIN	MAX	MEAN
1	APG-15	4	0.7230	1.4900	1.0875
2	APG-02	4	3.1200	10.3000	5.0225
3	APG-06	4	1.3900	3.7100	2.0825
4	APG-16	4	3.0700	3.3700	3.2250

Title: 60225262-45-(035-038)
File: 445cal.dat Transform: NO TRANSFORMATION

Summary Statistics on Data TABLE 2 of 2

GRP	IDENTIFICATION	VARIANCE	SD	SEM	C.V. %
1	APG-15	0.1477	0.3843	0.1921	35.3361
2	APG-02	12.3891	3.5198	1.7599	70.0809
3	APG-06	1.2113	1.1006	0.5503	52.8493
4	APG-16	0.0193	0.1389	0.0695	4.3077

Toxstat Version 3.5 Page____of____
Study # 60147216-445-(035-038)
ESTCP
Echinochloa crusgalli
Analysis of for Nutrient Uptake Factor: CALCIUM using Site Control

QA:CW 12/13/12
12/13/12

Title: 60225262-45-(035-038)
File: 445cal.dat Transform: LOG BASE 10(Y)

Shapiro - Wilk's Test for Normality

D = 0.3821
W = 0.8497

Critical W = 0.8440 (alpha = 0.01 , N = 16)
W = 0.8870 (alpha = 0.05 , N = 16)

Data PASS normality test (alpha = 0.01). Continue analysis.

Title: 60225262-45-(035-038)
File: 445cal.dat Transform: LOG BASE 10(Y)

Bartlett's Test for Homogeneity of Variance

Calculated B1 statistic = 10.1670 (p-value = 0.0172)

Data PASS B1 homogeneity test at 0.01 level. Continue analysis.

Critical B = 11.3449 (alpha = 0.01, df = 3)
= 7.8147 (alpha = 0.05, df = 3)

Toxstat Version 3.5 Page____of____
Study # 60147216-445-(035-038)
ESTCP
Echinochloa crusgalli
Analysis of Nutrient Uptake Factor: CALCIUM using Site Control

12/13/12
QA: CU 12/13/12

Title: 60225262-45-(035-038)
File: 445cal.dat Transform: LOG BASE 10(Y)

ANOVA Table

SOURCE	DF	SS	MS	F
Between	3	0.8983	0.2994	9.4038
Within (Error)	12	0.3821	0.0318	
Total	15	1.2804		

(p-value = 0.0018)

Critical F = 5.9525 (alpha = 0.01, df = 3,12)
= 3.4903 (alpha = 0.05, df = 3,12)

Since F > Critical F REJECT Ho: All equal (alpha = 0.05)

Title: 60225262-45-(035-038)
File: 445cal.dat Transform: LOG BASE 10(Y)

Dunnett's Test - TABLE 1 OF 2 Ho:Control=Treatment

GROUP	IDENTIFICATION	TRANSFORMED MEAN	MEAN CALCULATED IN ORIGINAL UNITS	TRANS T STAT	SIG 0.05
1	APG-15	0.0152	1.0875		
2	APG-02	0.6383	5.0225	4.9381	*
3	APG-06	0.2807	2.0825	2.1044	
4	APG-16	0.5082	3.2250	3.9073	*

Dunnett critical value = 2.6800 (2 Tailed, alpha = 0.05, df = 3,12)

Title: 60225262-45-(035-038)
File: 445cal.dat Transform: LOG BASE 10(Y)

Dunnett's Test - TABLE 2 OF 2 Ho:Control=Treatment

GROUP	IDENTIFICATION	NUM OF REPS	MIN SIG DIFF (IN ORIG. UNITS)	% OF CONTROL	DIFFERENCE FROM CONTROL
1	APG-15	4			
2	APG-02	4	0.5603	54.1	3.9350
3	APG-06	4	0.5603	54.1	0.9950
4	APG-16	4	0.5603	54.1	2.1375

Toxstat Version 3.5 Page_____of______
Study # (1) ~~60225262~~ 60147216 -445-(035-038)
Echinochloa crusgalli
Summary Statistics for Nutrient Uptake Factor for COPPER using Site Control GA:CW 12/13/12
ck 12/12/12

Title: 60225262-445-(035-038)
File: 445copp.dat Transform: NO TRANSFORMATION

Summary Statistics on Data TABLE 1 of 2

GRP	IDENTIFICATION	N	MIN	MAX	MEAN
1	APG-15	4	0.0130	0.0280	0.0178
2	APG-02	4	0.0540	0.1100	0.0845
3	APG-06	4	0.0750	0.1280	0.0995
4	APG-16	4	0.0220	0.0270	0.0245

Title: 60225262-445-(035-038)
File: 445copp.dat Transform: NO TRANSFORMATION

Summary Statistics on Data TABLE 2 of 2

GRP	IDENTIFICATION	VARIANCE	SD	SEM	C.V. %
1	APG-15	0.0000	0.0069	0.0035	39.1336
2	APG-02	0.0008	0.0282	0.0141	33.4237
3	APG-06	0.0005	0.0222	0.0111	22.3303
4	APG-16	0.0000	0.0024	0.0012	9.7162

(1) CW for AND 12/13/12 CF

```
Toxstat Version 3.5                                              Page_____of______
Study # ~~60225262~~(1)-445-(035-038)
         60147216
ESTCP
Echinochloa crusgalli
Analysis of Nutrient Uptake Factor for COPPER using Site Control
```

QA: CW 12/13/12
12/12/12

```
  Title:  60225262-445-(035-038)
  File:       445copp.dat            Transform:                LOG BASE 10(Y)

                    Shapiro - Wilk's Test for Normality
  ---------------------------------------------------------------------------

       D =    0.1719
       W =    0.9664

       Critical W  = 0.8440 (alpha = 0.01 , N = 16)
                W  = 0.8870 (alpha = 0.05 , N = 16)

  ---------------------------------------------------------------------------
  Data PASS normality test (alpha = 0.01). Continue analysis.


  Title:  60225262-445-(035-038)
  File:       445copp.dat            Transform:                LOG BASE 10(Y)

                 Bartlett's Test for Homogeneity of Variance
  ---------------------------------------------------------------------------

  Calculated B1 statistic =   4.0822               (p-value = 0.2527)

  Data PASS B1 homogeneity test at 0.01 level. Continue analysis.

  ---------------------------------------------------------------------------

  Critical B = 11.3449   (alpha = 0.01, df =   3)
             =  7.8147   (alpha = 0.05, df =   3)
```

(1) cw for ANP 12/13/12 E

Toxstat Version 3.5 Page_____of______

Study # ~~60225262~~① 60147216-445-(035-038)

ESTCP

Echinochloa crusgalli

Analysis of Nutrient Uptake Factor for COPPER using Site Control

QA:CW 12/13/12

CK 12/12/12

Title: 60225262-445-(035-038)

File: 445copp.dat Transform: LOG BASE 10(Y)

ANOVA Table

SOURCE	DF	SS	MS	F
Between	3	1.7071	0.5690	39.7182
Within (Error)	12	0.1719	0.0143	
Total	15	1.8790		

(p-value = 0.0000)

Critical F = 5.9525 (alpha = 0.01, df = 3,12)
= 3.4903 (alpha = 0.05, df = 3,12)

Since F > Critical F REJECT Ho: All equal (alpha = 0.05)

Title: 60225262-445-(035-038)

File: 445copp.dat Transform: LOG BASE 10(Y)

Dunnett's Test - TABLE 1 OF 2 Ho:Control=Treatment

GROUP	IDENTIFICATION	TRANSFORMED MEAN	MEAN CALCULATED IN ORIGINAL UNITS	TRANS T STAT	SIG 0.05
1	APG-15	-1.7722	0.0178		
2	APG-02	-1.0927	0.0845	8.0282	*
3	APG-06	-1.0103	0.0995	9.0019	*
4	APG-16	-1.6124	0.0245	1.8879	

Dunnett critical value = 2.6800 (2 Tailed, alpha = 0.05, df = 3,12)

Title: 60225262-445-(035-038)

File: 445copp.dat Transform: LOG BASE 10(Y)

Dunnett's Test - TABLE 2 OF 2 Ho:Control=Treatment

GROUP	IDENTIFICATION	NUM OF REPS	MIN SIG DIFF (IN ORIG. UNITS)	% OF CONTROL	DIFFERENCE FROM CONTROL
1	APG-15	4			
2	APG-02	4	0.0069	40.7	0.0668
3	APG-06	4	0.0069	40.7	0.0818
4	APG-16	4	0.0069	40.7	0.0068

①CW for ANP 12/13/12 E

Toxstat Version 3.5 Page____of____
Study # 60147216-445-(035-038)
ESTCP
Echinochloa crusgalli
Summary Statistics for Nutrient Factor: IRON using Site Control

dk 12/12/12
QA: CW 12/13/12

Title: 60225262-445-(035-038)
File: 445IRON.DAT Transform: NO TRANSFORMATION

Summary Statistics on Data TABLE 1 of 2

GRP	IDENTIFICATION	N	MIN	MAX	MEAN
1	APG-15	4	0.0030	0.0100	0.0058
2	APG-02	4	0.0060	0.0280	0.0170
3	APG-06	4	0.0100	0.0220	0.0138
4	APG-16	4	0.0020	0.0090	0.0053

Title: 60225262-445-(035-038)
File: 445IRON.DAT Transform: NO TRANSFORMATION

Summary Statistics on Data TABLE 2 of 2

GRP	IDENTIFICATION	VARIANCE	SD	SEM	C.V. %
1	APG-15	0.0000	0.0030	0.0015	51.9318
2	APG-02	0.0001	0.0106	0.0053	62.6224
3	APG-06	0.0000	0.0057	0.0028	41.3012
4	APG-16	0.0000	0.0030	0.0015	56.8777

Toxstat Version 3.5
Study # 60147216-445-(035-038)
ESTCP
Echinochloa crusgalli
Analysis of Nutrient Factor: IRON using Site Control

Page____of____

QA: cw 12\13\12
dk 12|12|12

Title: 60225262-445-(035-038)
File: 445IRON.DAT Transform: LOG BASE 10(Y)

Shapiro - Wilk's Test for Normality

D = 0.7513
W = 0.9282

Critical W = 0.8440 (alpha = 0.01 , N = 16)
W = 0.8870 (alpha = 0.05 , N = 16)

Data PASS normality test (alpha = 0.01). Continue analysis.

Title: 60225262-445-(035-038)
File: 445IRON.DAT Transform: LOG BASE 10(Y)

Bartlett's Test for Homogeneity of Variance

Calculated B1 statistic = 1.2989 (p-value = 0.7294)

Data PASS B1 homogeneity test at 0.01 level. Continue analysis.

Critical B = 11.3449 (alpha = 0.01, df = 3)
= 7.8147 (alpha = 0.05, df = 3)

Toxstat Version 3.5 Page____of____
Study # 60147216-445-(035-038)
ESTCP
Echinochloa crusgalli
Analysis of Nutrient Factor: IRON using Site Control

QA:CW 12/13/12
CK 12/12/12

Title: 60225262-445-(035-038)
File: 445IRON.DAT Transform: LOG BASE 10(Y)

ANOVA Table

SOURCE	DF	SS	MS	F
Between	3	0.7982	0.2661	4.2500
Within (Error)	12	0.7513	0.0626	
Total	15	1.5495		

(p-value = 0.0291)

Critical F = 5.9525 (alpha = 0.01, df = 3,12)
= 3.4903 (alpha = 0.05, df = 3,12)

Since F > Critical F REJECT Ho: All equal (alpha = 0.05)

Title: 60225262-445-(035-038)
File: 445IRON.DAT Transform: LOG BASE 10(Y)

Dunnett's Test - TABLE 1 OF 2 Ho:Control=Treatment

GROUP	IDENTIFICATION	TRANSFORMED MEAN	MEAN CALCULATED IN ORIGINAL UNITS	TRANS T STAT	SIG 0.05
1	APG-15	-2.2812	0.0058		
2	APG-02	-1.8486	0.0170	2.4452	
3	APG-06	-1.8859	0.0138	2.2344	
4	APG-16	-2.3411	0.0053	0.3385	

Dunnett critical value = 2.6800 (2 Tailed, alpha = 0.05, df = 3,12)

Title: 60225262-445-(035-038)
File: 445IRON.DAT Transform: LOG BASE 10(Y)

Dunnett's Test - TABLE 2 OF 2 Ho:Control=Treatment

GROUP	IDENTIFICATION	NUM OF REPS	MIN SIG DIFF (IN ORIG. UNITS)	% OF CONTROL	DIFFERENCE FROM CONTROL
1	APG-15	4			
2	APG-02	4	0.0035	66.4	0.0112
3	APG-06	4	0.0035	66.4	0.0080
4	APG-16	4	0.0035	66.4	0.0005

Toxstat Version 3.5 Page____of_____
Study # 60147216-445-(035-038)
ESTCP
Echinochloa crusgalli
Summary Statistics for Nutrient Uptake Factor: MAGNESIUM using Site Control

QA:CW 12/13/12
dk 12/12/12

Title: 60225262-445-(035-038)
File: 445mg.dat Transform: NO TRANSFORMATION

Summary Statistics on Data TABLE 1 of 2

GRP	IDENTIFICATION	N	MIN	MAX	MEAN
1	APG-15	4	1.7200	1.9300	1.8550
2	APG-02	4	7.8700	9.4900	8.7525
3	APG-06	4	2.9000	3.8300	3.5825
4	APG-16	4	2.9400	3.5000	3.1425

Title: 60225262-445-(035-038)
File: 445mg.dat Transform: NO TRANSFORMATION

Summary Statistics on Data TABLE 2 of 2

GRP	IDENTIFICATION	VARIANCE	SD	SEM	C.V. %
1	APG-15	0.0090	0.0947	0.0473	5.1047
2	APG-02	0.6212	0.7882	0.3941	9.0052
3	APG-06	0.2072	0.4552	0.2276	12.7068
4	APG-16	0.0631	0.2512	0.1256	7.9930

Toxstat Version 3.5 Page____of_____
Study # 60147216-445-(035-038)
ESTCP
Echinochloa crusgalli
Summary Statistics for Nutrient Uptake Factor: MAGNESIUM using Site Control

QA: CW 12/13/12
[illegible] 12/12/12

```
  Title:  60225262-445-(035-038)
  File:        445mg.dat              Transform:            NO TRANSFORMATION

                  Shapiro - Wilk's Test for Normality
  ------------------------------------------------------------------------------

       D =   2.7015
       W =   0.9709

       Critical W  = 0.8440 (alpha = 0.01 , N = 16)
                W  = 0.8870 (alpha = 0.05 , N = 16)

  ------------------------------------------------------------------------------
  Data PASS normality test (alpha = 0.01). Continue analysis.


  Title:  60225262-445-(035-038)
  File:        445mg.dat              Transform:            NO TRANSFORMATION

               Bartlett's Test for Homogeneity of Variance
  ------------------------------------------------------------------------------

  Calculated B1 statistic =   9.3856              (p-value = 0.0246)

  Data PASS B1 homogeneity test at 0.01 level. Continue analysis.
  ------------------------------------------------------------------------------

  Critical B = 11.3449   (alpha = 0.01, df =  3)
             =  7.8147   (alpha = 0.05, df =  3)
```

Toxstat Version 3.5 Page____of_____
Study # 60147216-445-(035-038)
ESTCP
Echinochloa crusgalli
Summary Statistics for Nutrient Uptake Factor: MAGNESIUM using Site Control

QA:CW 12/13/12
12/12/12

Title: 60225262-445-(035-038)
File: 445mg.dat Transform: NO TRANSFORMATION

ANOVA Table

SOURCE	DF	SS	MS	F
Between	3	110.6120	36.8707	163.7772
Within (Error)	12	2.7015	0.2251	
Total	15	113.3135		

(p-value = 0.0000)

Critical F = 5.9525 (alpha = 0.01, df = 3,12)
= 3.4903 (alpha = 0.05, df = 3,12)

Since F > Critical F REJECT Ho: All equal (alpha = 0.05)

Title: 60225262-445-(035-038)
File: 445mg.dat Transform: NO TRANSFORMATION

Dunnett's Test - TABLE 1 OF 2 Ho:Control=Treatment

GROUP	IDENTIFICATION	TRANSFORMED MEAN	MEAN CALCULATED IN ORIGINAL UNITS	T STAT	SIG 0.05
1	APG-15	1.8550	1.8550		
2	APG-02	8.7525	8.7525	20.5586	*
3	APG-06	3.5825	3.5825	5.1490	*
4	APG-16	3.1425	3.1425	3.8375	*

Dunnett critical value = 2.6800 (2 Tailed, alpha = 0.05, df = 3,12)

Title: 60225262-445-(035-038)
File: 445mg.dat Transform: NO TRANSFORMATION

Dunnett's Test - TABLE 2 OF 2 Ho:Control=Treatment

GROUP	IDENTIFICATION	NUM OF REPS	MIN SIG DIFF (IN ORIG. UNITS)	% OF CONTROL	DIFFERENCE FROM CONTROL
1	APG-15	4			
2	APG-02	4	0.8992	48.5	6.8975
3	APG-06	4	0.8992	48.5	1.7275
4	APG-16	4	0.8992	48.5	1.2875

Toxstat Version 3.5 Page_____of_____
Study # 60147216-445-(035-038)
ESTCP
Echinochloa crusgalli
Summary Statistics for Nutrient Uptake Factor: Manganese using Site Control

QA: CW 12/13/12
12/12/12

Title: 60225262-445-(035-038)
File: 445MN.DAT Transform: NO TRANSFORMATION

Summary Statistics on Data TABLE 1 of 2

GRP	IDENTIFICATION	N	MIN	MAX	MEAN
1	APG-15	4	1.0100	1.4700	1.2550
2	APG-02	4	4.5800	9.3700	6.8850
3	APG-06	4	0.6990	3.4000	1.7023
4	APG-16	4	0.8090	2.2000	1.6923

Title: 60225262-445-(035-038)
File: 445MN.DAT Transform: NO TRANSFORMATION

Summary Statistics on Data TABLE 2 of 2

GRP	IDENTIFICATION	VARIANCE	SD	SEM	C.V. %
1	APG-15	0.0358	0.1893	0.0946	15.0834
2	APG-02	5.0408	2.2452	1.1226	32.6097
3	APG-06	1.4347	1.1978	0.5989	70.3649
4	APG-16	0.3865	0.6217	0.3109	36.7398

Toxstat Version 3.5
Study # 60147216-445-(035-038)
ESTCP
Echinochloa crusgalli
Analysis of Nutrient Uptake Factor: Manganese using Site Control

Page_____of_____

QA:CN 12/13/12
12/12/12

Title: 60225262-445-(035-038)
File: 445MN.DAT Transform: LOG BASE 10(Y)

Shapiro - Wilk's Test for Normality

D = 0.4550
W = 0.9625

Critical W = 0.8440 (alpha = 0.01 , N = 16)
W = 0.8870 (alpha = 0.05 , N = 16)

Data PASS normality test (alpha = 0.01). Continue analysis.

Title: 60225262-445-(035-038)
File: 445MN.DAT Transform: LOG BASE 10(Y)

Bartlett's Test for Homogeneity of Variance

Calculated B1 statistic = 4.8270 (p-value = 0.1849)

Data PASS B1 homogeneity test at 0.01 level. Continue analysis.

Critical B = 11.3449 (alpha = 0.01, df = 3)
= 7.8147 (alpha = 0.05, df = 3)

Toxstat Version 3.5 Page_____of_____
Study # 60147216-445-(035-038)
ESTCP
Echinochloa crusgalli
Analysis of Nutrient Uptake Factor: Manganese using Site Control

*12|12|12
QA: 12\13\12

Title: 60225262-445-(035-038)
File: 445MN.DAT Transform: LOG BASE 10(Y)

ANOVA Table

SOURCE	DF	SS	MS	F
Between	3	1.3704	0.4568	12.0475
Within (Error)	12	0.4550	0.0379	
Total	15	1.8254		

(p-value = 0.0006)

Critical F = 5.9525 (alpha = 0.01, df = 3,12)
= 3.4903 (alpha = 0.05, df = 3,12)

Since F > Critical F REJECT Ho: All equal (alpha = 0.05)

Title: 60225262-445-(035-038)
File: 445MN.DAT Transform: LOG BASE 10(Y)

Dunnett's Test - TABLE 1 OF 2 Ho:Control=Treatment

GROUP	IDENTIFICATION	TRANSFORMED MEAN	MEAN CALCULATED IN ORIGINAL UNITS	TRANS T STAT	SIG 0.05
1	APG-15	0.0948	1.2550		
2	APG-02	0.8199	6.8850	5.2664	*
3	APG-06	0.1547	1.7023	0.4351	
4	APG-16	0.1989	1.6923	0.7560	

Dunnett critical value = 2.6800 (2 Tailed, alpha = 0.05, df = 3,12)

Title: 60225262-445-(035-038)
File: 445MN.DAT Transform: LOG BASE 10(Y)

Dunnett's Test - TABLE 2 OF 2 Ho:Control=Treatment

GROUP	IDENTIFICATION	NUM OF REPS	MIN SIG DIFF (IN ORIG. UNITS)	% OF CONTROL	DIFFERENCE FROM CONTROL
1	APG-15	4			
2	APG-02	4	0.7121	57.2	5.6300
3	APG-06	4	0.7121	57.2	0.4472
4	APG-16	4	0.7121	57.2	0.4372

Toxstat Version 3.5
Study # 60147216-445-(035-038)
ESTCP
Echinochloa crusgalli
Summary Statistics for Nutrient Uptake Factor: PHOSPHORUS using Site Control

Page____of____
QA:CW 12/14/12
JK 12/13/12

Title: 60225262-445-(035-038)
File: 445p.dat   Transform: NO TRANSFORMATION

Summary Statistics on Data   TABLE 1 of 2

GRP	IDENTIFICATION	N	MIN	MAX	MEAN
1	APG-15	4	1.6500	1.9900	1.8250
2	APG-02	4	2.3700	3.2900	2.8475
3	APG-06	4	3.7300	4.5600	4.0375
4	APG-16	4	1.8000	2.5900	2.1975

Title: 60225262-445-(035-038)
File: 445p.dat   Transform: NO TRANSFORMATION

Summary Statistics on Data   TABLE 2 of 2

GRP	IDENTIFICATION	VARIANCE	SD	SEM	C.V. %
1	APG-15	0.0306	0.1748	0.0874	9.5799
2	APG-02	0.1415	0.3762	0.1881	13.2100
3	APG-06	0.1303	0.3610	0.1805	8.9402
4	APG-16	0.1051	0.3242	0.1621	14.7521

Toxstat Version 3.5 Page____of____
Study # 60147216-445-(035-038)
ESTCP
Echinochloa crusgalli
Analysis of Nutrient Uptake Factor: PHOSPHORUS using Site Control

ds 12/13/12
QA: CW 12/14/12

Title: 60225262-445-(035-038)
File: 445p.dat Transform: NO TRANSFORMATION

Shapiro - Wilk's Test for Normality

D = 1.2223
W = 0.9652

Critical W = 0.8440 (alpha = 0.01 , N = 16)
W = 0.8870 (alpha = 0.05 , N = 16)

Data PASS normality test (alpha = 0.01). Continue analysis.

Title: 60225262-445-(035-038)
File: 445p.dat Transform: NO TRANSFORMATION

Bartlett's Test for Homogeneity of Variance

Calculated B1 statistic = 1.5743 (p-value = 0.6652)

Data PASS B1 homogeneity test at 0.01 level. Continue analysis.

Critical B = 11.3449 (alpha = 0.01, df = 3)
= 7.8147 (alpha = 0.05, df = 3)

Toxstat Version 3.5 Page____of____
Study # 60147216-445-(035-038)
ESTCP
Echinochloa crusgalli
Analysis of Nutrient Uptake Factor: PHOSPHORUS using Site Control

12/13/12
QA: CW 12/14/12

Title: 60225262-445-(035-038)
File: 445p.dat Transform: NO TRANSFORMATION

ANOVA Table

SOURCE	DF	SS	MS	F
Between	3	11.3036	3.7679	36.9906
Within (Error)	12	1.2223	0.1019	
Total	15	12.5259		

(p-value = 0.0000)

Critical F = 5.9525 (alpha = 0.01, df = 3,12)
= 3.4903 (alpha = 0.05, df = 3,12)

Since F > Critical F REJECT Ho: All equal (alpha = 0.05)

Title: 60225262-445-(035-038)
File: 445p.dat Transform: NO TRANSFORMATION

Dunnett's Test - TABLE 1 OF 2 Ho:Control=Treatment

GROUP	IDENTIFICATION	TRANSFORMED MEAN	MEAN CALCULATED IN ORIGINAL UNITS	T STAT	SIG 0.05
1	APG-15	1.8250	1.8250		
2	APG-02	2.8475	2.8475	4.5308	*
3	APG-06	4.0375	4.0375	9.8038	*
4	APG-16	2.1975	2.1975	1.6506	

Dunnett critical value = 2.6800 (2 Tailed, alpha = 0.05, df = 3,12)

Title: 60225262-445-(035-038)
File: 445p.dat Transform: NO TRANSFORMATION

Dunnett's Test - TABLE 2 OF 2 Ho:Control=Treatment

GROUP	IDENTIFICATION	NUM OF REPS	MIN SIG DIFF (IN ORIG. UNITS)	% OF CONTROL	DIFFERENCE FROM CONTROL
1	APG-15	4			
2	APG-02	4	0.6048	33.1	1.0225
3	APG-06	4	0.6048	33.1	2.2125
4	APG-16	4	0.6048	33.1	0.3725

Toxstat Version 3.5 Page____of____
Study # 60147216-445-(035-038) QA:CW 12/13/12
ESTCP 12/12/12
Echinochloa crusgalli
Summary Statistics for Nutrient Uptake Factor: POTASSIUM using Site Control

Title: 60225262-445-(035-038)
File: 445k.dat Transform: NO TRANSFORMATION

Summary Statistics on Data TABLE 1 of 2

GRP	IDENTIFICATION	N	MIN	MAX	MEAN
1	APG-15	4	26.4000	33.8000	30.8750
2	APG-02	4	50.7000	62.2000	56.6250
3	APG-06	4	54.3000	65.5000	59.1500
4	APG-16	4	20.8000	31.0000	26.6000

Title: 60225262-445-(035-038)
File: 445k.dat Transform: NO TRANSFORMATION

Summary Statistics on Data TABLE 2 of 2

GRP	IDENTIFICATION	VARIANCE	SD	SEM	C.V. %
1	APG-15	11.5292	3.3955	1.6977	10.9974
2	APG-02	24.7492	4.9749	2.4874	8.7856
3	APG-06	32.8633	5.7327	2.8663	9.6917
4	APG-16	25.7000	5.0695	2.5348	19.0583

Toxstat Version 3.5
Study # 60147216-445-(035-038)
ESTCP
Echinochloa crusgalli
Analysis of Nutrient Uptake Factor: POTASSIUM using Site Control

Page____of____

[initials] 12/12/12
QA: *[initials]* 12/13/12

Title: 60225262-445-(035-038)
File: 445k.dat Transform: NO TRANSFORMATION

Shapiro - Wilk's Test for Normality

D = 284.5250
W = 0.9017

Critical W = 0.8440 (alpha = 0.01 , N = 16)
W = 0.8870 (alpha = 0.05 , N = 16)

Data PASS normality test (alpha = 0.01). Continue analysis.

Title: 60225262-445-(035-038)
File: 445k.dat Transform: NO TRANSFORMATION

Bartlett's Test for Homogeneity of Variance

Calculated B1 statistic = 0.7142 (p-value = 0.8699)

Data PASS B1 homogeneity test at 0.01 level. Continue analysis.

Critical B = 11.3449 (alpha = 0.01, df = 3)
= 7.8147 (alpha = 0.05, df = 3)

Toxstat Version 3.5 Page____of____
Study # 60147216-445-(035-038)
ESTCP
Echinochloa crusgalli
Analysis of Nutrient Uptake Factor: POTASSIUM using Site Control

ok 12/12/12
QA: cw 12/13/12

Title: 60225262-445-(035-038)
File: 445k.dat Transform: NO TRANSFORMATION

ANOVA Table

SOURCE	DF	SS	MS	F
Between	3	3448.1925	1149.3975	48.4765
Within (Error)	12	284.5250	23.7104	
Total	15	3732.7175		

(p-value = 0.0000)

Critical F = 5.9525 (alpha = 0.01, df = 3,12)
= 3.4903 (alpha = 0.05, df = 3,12)

Since F > Critical F REJECT Ho: All equal (alpha = 0.05)

Title: 60225262-445-(035-038)
File: 445k.dat Transform: NO TRANSFORMATION

Dunnett's Test - TABLE 1 OF 2 Ho:Control=Treatment

GROUP	IDENTIFICATION	TRANSFORMED MEAN	MEAN CALCULATED IN ORIGINAL UNITS	T STAT	SIG 0.05
1	APG-15	30.8750	30.8750		
2	APG-02	56.6250	56.6250	7.4786	*
3	APG-06	59.1500	59.1500	8.2120	*
4	APG-16	26.6000	26.6000	1.2416	

Dunnett critical value = 2.6800 (2 Tailed, alpha = 0.05, df = 3,12)

Title: 60225262-445-(035-038)
File: 445k.dat Transform: NO TRANSFORMATION

Dunnett's Test - TABLE 2 OF 2 Ho:Control=Treatment

GROUP	IDENTIFICATION	NUM OF REPS	MIN SIG DIFF (IN ORIG. UNITS)	% OF CONTROL	DIFFERENCE FROM CONTROL
1	APG-15	4			
2	APG-02	4	9.2276	29.9	25.7500
3	APG-06	4	9.2276	29.9	28.2750
4	APG-16	4	9.2276	29.9	4.2750

Toxstat Version 3.5 Page____of_____
Study # 60147216-445-(035-038)
ESTCP
Echinochloa crusgalli
Summary Statistics for Plant Nutrient Uptake Factor: SODIUM using Site Control

QA:CW 12\13\12
12|12|12

Title: 60225262-445-(035*-038)
File: 445na.dat Transform: NO TRANSFORMATION

Summary Statistics on Data TABLE 1 of 2

GRP	IDENTIFICATION	N	MIN	MAX	MEAN
1	APG-15	4	14.2000	45.5000	25.1000
2	APG-02	4	7.8200	51.7000	21.3050
3	APG-06	4	7.3400	40.4000	23.2850
4	APG-16	4	11.3000	17.8000	15.4500

Title: 60225262-445-(035*-038)
File: 445na.dat Transform: NO TRANSFORMATION

Summary Statistics on Data TABLE 2 of 2

GRP	IDENTIFICATION	VARIANCE	SD	SEM	C.V. %
1	APG-15	197.7000	14.0606	7.0303	56.0183
2	APG-02	420.9068	20.5160	10.2580	96.2967
3	APG-06	203.5236	14.2662	7.1331	61.2676
4	APG-16	8.3233	2.8850	1.4425	18.6733

Toxstat Version 3.5
Study # 60147216-445-(035-038)
ESTCP
Echinochloa crusgalli
Analysis of for Plant Nutrient Uptake Factor: SODIUM using Site Control

Page____of_____

QA: CW 12/13/12
12/12/12

Title: 60225262-445-(035*-038)
File: 445na.dat Transform: NO TRANSFORMATION

Shapiro - Wilk's Test for Normality

D = 2491.3610
W = 0.8997

Critical W = 0.8440 (alpha = 0.01 , N = 16)
W = 0.8870 (alpha = 0.05 , N = 16)

Data PASS normality test (alpha = 0.01). Continue analysis.

Title: 60225262-445-(035*-038)
File: 445na.dat Transform: NO TRANSFORMATION

Bartlett's Test for Homogeneity of Variance

Calculated B1 statistic = 6.7927 (p-value = 0.0788)

Data PASS B1 homogeneity test at 0.01 level. Continue analysis.

Critical B = 11.3449 (alpha = 0.01, df = 3)
= 7.8147 (alpha = 0.05, df = 3)

Toxstat Version 3.5 Page____of_____
Study # 60147216-445-(035-038)
ESTCP
Echinochloa crusgalli
Analysis of Plant Nutrient Uptake Factor: SODIUM using Site Control

QA:CW 12/13/12
12/12/12

Title: 60225262-445-(035*-038)
File: 445na.dat Transform: NO TRANSFORMATION

ANOVA Table

SOURCE	DF	SS	MS	F
Between	3	210.4074	70.1358	0.3378
Within (Error)	12	2491.3610	207.6134	
Total	15	2701.7684		

(p-value = 0.7984)

Critical F = 5.9525 (alpha = 0.01, df = 3,12)
= 3.4903 (alpha = 0.05, df = 3,12)

Since F < Critical F FAIL TO REJECT Ho: All equal (alpha = 0.05)

Title: 60225262-445-(035*-038)
File: 445na.dat Transform: NO TRANSFORMATION

Dunnett's Test - TABLE 1 OF 2 Ho:Control=Treatment

GROUP	IDENTIFICATION	TRANSFORMED MEAN	MEAN CALCULATED IN ORIGINAL UNITS	T STAT	SIG 0.05
1	APG-15	25.1000	25.1000		
2	APG-02	21.3050	21.3050	0.3725	
3	APG-06	23.2850	23.2850	0.1781	
4	APG-16	15.4500	15.4500	0.9471	

Dunnett critical value = 2.6800 (2 Tailed, alpha = 0.05, df = 3,12)

Title: 60225262-445-(035*-038)
File: 445na.dat Transform: NO TRANSFORMATION

Dunnett's Test - TABLE 2 OF 2 Ho:Control=Treatment

GROUP	IDENTIFICATION	NUM OF REPS	MIN SIG DIFF (IN ORIG. UNITS)	% OF CONTROL	DIFFERENCE FROM CONTROL
1	APG-15	4			
2	APG-02	4	27.3053	108.8	3.7950
3	APG-06	4	27.3053	108.8	1.8150
4	APG-16	4	27.3053	108.8	9.6500

Toxstat Version 3.5 Page____of_____
Study # 60147216-445-(035-038) QA: cw 12/13/12
ESTCP 12/12/12
Echinochloa crusgalli
Summary Statistics for Nutrient Uptake Factor: SULFUR using Site Control

Title: 60225262-445-(035-038)
File: 445s.dat Transform: NO TRANSFORMATION

Summary Statistics on Data TABLE 1 of 2

GRP	IDENTIFICATION	N	MIN	MAX	MEAN
1	APG-15	4	2.2700	4.1300	3.0900
2	APG-02	4	2.6100	6.4200	3.7625
3	APG-06	4	3.0100	5.5800	4.0300
4	APG-16	4	1.2800	1.3900	1.3400

Title: 60225262-445-(035-038)
File: 445s.dat Transform: NO TRANSFORMATION

Summary Statistics on Data TABLE 2 of 2

GRP	IDENTIFICATION	VARIANCE	SD	SEM	C.V. %
1	APG-15	0.8018	0.8954	0.4477	28.9784
2	APG-02	3.2128	1.7924	0.8962	47.6390
3	APG-06	1.1946	1.0930	0.5465	27.1210
4	APG-16	0.0025	0.0497	0.0248	3.7064

QA: CW 12/13/12
12/12/12

```
Title:  60225262-445-(035-038)
File:          445s.dat            Transform:              LOG BASE 10(Y)

                 Shapiro - Wilk's Test for Normality
----------------------------------------------------------------------------

     D =   0.1829
     W =   0.9035

     Critical W  = 0.8440 (alpha = 0.01 , N = 16)
              W  = 0.8870 (alpha = 0.05 , N = 16)

----------------------------------------------------------------------------

Data PASS normality test (alpha = 0.01). Continue analysis.


Title:  60225262-445-(035-038)
File:          445s.dat            Transform:              LOG BASE 10(Y)

              Bartlett's Test for Homogeneity of Variance
----------------------------------------------------------------------------

Calculated B1 statistic =  9.1488             (p-value = 0.0274)

Data PASS B1 homogeneity test at 0.01 level. Continue analysis.

----------------------------------------------------------------------------

Critical B = 11.3449  (alpha = 0.01, df =  3)
           =  7.8147  (alpha = 0.05, df =  3)
```

Toxstat Version 3.5 Page____of_____
Study # 60147216-445-(035-038)
ESTCP
Echinochloa crusgalli
Analysis of Nutrient Uptake Factor: SULFUR using Site Control

QA: CW 12/13/12
dk 12/12/12

Title: 60225262-445-(035-038)
File: 445s.dat Transform: LOG BASE 10(Y)

ANOVA Table

SOURCE	DF	SS	MS	F
Between	3	0.5360	0.1787	11.7222
Within (Error)	12	0.1829	0.0152	
Total	15	0.7189		

(p-value = 0.0007)

Critical F = 5.9525 (alpha = 0.01, df = 3,12)
= 3.4903 (alpha = 0.05, df = 3,12)

Since F > Critical F REJECT Ho: All equal (alpha = 0.05)

Title: 60225262-445-(035-038)
File: 445s.dat Transform: LOG BASE 10(Y)

Dunnett's Test - TABLE 1 OF 2 Ho:Control=Treatment

GROUP	IDENTIFICATION	TRANSFORMED MEAN	MEAN CALCULATED IN ORIGINAL UNITS	TRANS T STAT	SIG 0.05
1	APG-15	0.4762	3.0900		
2	APG-02	0.5446	3.7625	0.7840	
3	APG-06	0.5942	4.0300	1.3515	
4	APG-16	0.1269	1.3400	4.0016	*

Dunnett critical value = 2.6800 (2 Tailed, alpha = 0.05, df = 3,12)

Title: 60225262-445-(035-038)
File: 445s.dat Transform: LOG BASE 10(Y)

Dunnett's Test - TABLE 2 OF 2 Ho:Control=Treatment

GROUP	IDENTIFICATION	NUM OF REPS	MIN SIG DIFF (IN ORIG. UNITS)	% OF CONTROL	DIFFERENCE FROM CONTROL
1	APG-15	4			
2	APG-02	4	1.2468	41.6	0.6725
3	APG-06	4	1.2468	41.6	0.9400
4	APG-16	4	1.2468	41.6	1.7500

Toxstat Version 3.5 Page____of____
Study # 60147216-445-(035-038)
ESTCP
Echinochloa crusgalli dr 12/12/12
Summary Statistics for Nutrient Uptake Factor: ZINC using Site Control QA: cw 12/13/12

Title: 60225262-445-(035-038)
File: 445zinc.dat Transform: NO TRANSFORMATION

Summary Statistics on Data TABLE 1 of 2

GRP	IDENTIFICATION	N	MIN	MAX	MEAN
1	APG-15	4	0.0540	0.1520	0.1125
2	APG-02	4	0.3850	2.0900	0.8618
3	APG-06	4	0.1740	0.4210	0.3230
4	APG-16	4	0.0840	0.2240	0.1630

Title: 60225262-445-(035-038)
File: 445zinc.dat Transform: NO TRANSFORMATION

Summary Statistics on Data TABLE 2 of 2

GRP	IDENTIFICATION	VARIANCE	SD	SEM	C.V. %
1	APG-15	0.0021	0.0455	0.0228	40.4778
2	APG-02	0.6728	0.8202	0.4101	95.1804
3	APG-06	0.0110	0.1051	0.0525	32.5249
4	APG-16	0.0035	0.0588	0.0294	36.0626

Toxstat Version 3.5
Study # 60147216-445-(035-038)
ESTCP
Echinochloa crusgalli
Analysis of Nutrient Uptake Factor: ZINC using Site Control

Page____of____

QA:CW 12/13/12
CK 12/12/12

Title: 60225262-445-(035-038)
File: 445zinc.dat Transform: LOG BASE 10(Y)

Shapiro - Wilk's Test for Normality

D = 0.6576
W = 0.9246

Critical W = 0.8440 (alpha = 0.01 , N = 16)
W = 0.8870 (alpha = 0.05 , N = 16)

Data PASS normality test (alpha = 0.01). Continue analysis.

Title: 60225262-445-(035-038)
File: 445zinc.dat Transform: LOG BASE 10(Y)

Bartlett's Test for Homogeneity of Variance

Calculated B1 statistic = 1.6903 (p-value = 0.6391)

Data PASS B1 homogeneity test at 0.01 level. Continue analysis.

Critical B = 11.3449 (alpha = 0.01, df = 3)
= 7.8147 (alpha = 0.05, df = 3)

QCW 12/13/12 E

Toxstat Version 3.5 Page____of____
Study # 60147216-445-(035-038)
ESTCP
Echinochloa crusgalli
Analysis of Nutrient Uptake Factor: ZINC using Site Control

ꝃ 12/12/12
QA: cu 12/13/12

Title: 60225262-445-(035-038)
File: 445zinc.dat Transform: LOG BASE 10(Y)

ANOVA Table

SOURCE	DF	SS	MS	F
Between	3	1.4947	0.4982	9.0915
Within (Error)	12	0.6576	0.0548	
Total	15	2.1524		

(p-value = 0.0020)

Critical F = 5.9525 (alpha = 0.01, df = 3,12)
= 3.4903 (alpha = 0.05, df = 3,12)

Since F > Critical F REJECT Ho: All equal (alpha = 0.05)

Title: 60225262-445-(035-038)
File: 445zinc.dat Transform: LOG BASE 10(Y)

Dunnett's Test - TABLE 1 OF 2 Ho:Control=Treatment

GROUP	IDENTIFICATION	TRANSFORMED MEAN	MEAN CALCULATED IN ORIGINAL UNITS	TRANS T STAT	SIG 0.05
1	APG-15	-0.9822	0.1125		
2	APG-02	-0.1803	0.8618	4.8444	*
3	APG-06	-0.5127	0.3230	2.8363	*
4	APG-16	-0.8140	0.1630	1.0157	

Dunnett critical value = 2.6800 (2 Tailed, alpha = 0.05, df = 3,12)

Title: 60225262-445-(035-038)
File: 445zinc.dat Transform: LOG BASE 10(Y)

Dunnett's Test - TABLE 2 OF 2 Ho:Control=Treatment

GROUP	IDENTIFICATION	NUM OF REPS	MIN SIG DIFF (IN ORIG. UNITS)	% OF CONTROL	DIFFERENCE FROM CONTROL
1	APG-15	4			
2	APG-02	4	0.0667	64.0	0.7493
3	APG-06	4	0.0667	64.0	0.2105
4	APG-16	4	0.0667	64.0	0.0505

Toxstat Version 3.5
Study # 60147216-445-(035-038)
ESTCP
Echinochloa crusgalli
Summary Statistics for Nutrient Uptake Factor: NITROGEN using Site Control

Page____of____

QA:CU 12/13/12
12/12/12

Title: 60225262-445-(035-038)
File: 445nit.dat Transform: NO TRANSFORMATION

Summary Statistics on Data TABLE 1 of 2

GRP	IDENTIFICATION	N	MIN	MAX	MEAN
1	APG-15	4	0.8380	0.9630	0.9128
2	APG-02	4	0.6380	0.7640	0.6912
3	APG-06	4	2.1400	2.3400	2.2425
4	APG-16	4	0.9600	1.1300	1.0650

Title: 60225262-445-(035-038)
File: 445nit.dat Transform: NO TRANSFORMATION

Summary Statistics on Data TABLE 2 of 2

GRP	IDENTIFICATION	VARIANCE	SD	SEM	C.V. %
1	APG-15	0.0028	0.0530	0.0265	5.8017
2	APG-02	0.0033	0.0572	0.0286	8.2813
3	APG-06	0.0068	0.0826	0.0413	3.6840
4	APG-16	0.0055	0.0742	0.0371	6.9636

Toxstat Version 3.5
Study # 60147216-445-(035-038)
ESTCP
Echinochloa crusgalli
Analysis of Nutrient Uptake Factor: NITROGEN using Site Control

QA: CW 12\13\12
12|12|12

Title: 60225262-445-(035-038)
File: 445nit.dat Transform: NO TRANSFORMATION

Shapiro - Wilk's Test for Normality

D = 0.0552
W = 0.9545

Critical W = 0.8440 (alpha = 0.01 , N = 16)
W = 0.8870 (alpha = 0.05 , N = 16)

Data PASS normality test (alpha = 0.01). Continue analysis.

Title: 60225262-445-(035-038)
File: 445nit.dat Transform: NO TRANSFORMATION

Bartlett's Test for Homogeneity of Variance

Calculated B1 statistic = 0.6906 (p-value = 0.8754)

Data PASS B1 homogeneity test at 0.01 level. Continue analysis.

Critical B = 11.3449 (alpha = 0.01, df = 3)
= 7.8147 (alpha = 0.05, df = 3)

Toxstat Version 3.5
Study # 60147216-445-(035-038)
ESTCP
Echinochloa crusgalli
Analysis of Nutrient Uptake Factor: NITROGEN using Site Control

Page____of____

QA:cw 12/13/12
dk 12/12/12

Title: 60225262-445-(035-038)
File: 445nit.dat Transform: NO TRANSFORMATION

ANOVA Table

SOURCE	DF	SS	MS	F
Between	3	5.7730	1.9243	418.1967
Within (Error)	12	0.0552	0.0046	
Total	15	5.8283		

(p-value = 0.0000)

Critical F = 5.9525 (alpha = 0.01, df = 3,12)
= 3.4903 (alpha = 0.05, df = 3,12)

Since F > Critical F REJECT Ho: All equal (alpha = 0.05)

Title: 60225262-445-(035-038)
File: 445nit.dat Transform: NO TRANSFORMATION

Dunnett's Test - TABLE 1 OF 2 Ho:Control=Treatment

GROUP	IDENTIFICATION	TRANSFORMED MEAN	MEAN CALCULATED IN ORIGINAL UNITS	T STAT	SIG 0.05
1	APG-15	0.9128	0.9128		
2	APG-02	0.6912	0.6912	4.6178	*
3	APG-06	2.2425	2.2425	27.7226	*
4	APG-16	1.0650	1.0650	3.1741	*

Dunnett critical value = 2.6800 (2 Tailed, alpha = 0.05, df = 3,12)

Title: 60225262-445-(035-038)
File: 445nit.dat Transform: NO TRANSFORMATION

Dunnett's Test - TABLE 2 OF 2 Ho:Control=Treatment

GROUP	IDENTIFICATION	NUM OF REPS	MIN SIG DIFF (IN ORIG. UNITS)	% OF CONTROL	DIFFERENCE FROM CONTROL
1	APG-15	4			
2	APG-02	4	0.1285	14.1	0.2215
3	APG-06	4	0.1285	14.1	1.3297
4	APG-16	4	0.1285	14.1	0.1523

Toxstat Version 3.5 Page____of_____
Study # 60147216-445-(035-038)
ESTCP
Echinochloa crusgalli
Summary Statistics for Nutrient Uptake Factor: BORON using Lab Control

QA: CW 12/13/12
12/13/12

Title: 60225262-445-(035-038)
File: 445boro.dat Transform: NO TRANSFORMATION

Summary Statistics on Data TABLE 1 of 2

GRP	IDENTIFICATION	N	MIN	MAX	MEAN
1	Control	4	3.7400	4.2600	3.9825
2	APG-02	4	4.0300	7.5000	5.1325
3	APG-06	4	2.5100	2.8900	2.6725
4	APG-16	4	1.2200	1.9800	1.6875
5	APG-15	4	1.2500	1.9500	1.6375

Title: 60225262-445-(035-038)
File: 445boro.dat Transform: NO TRANSFORMATION

Summary Statistics on Data TABLE 2 of 2

GRP	IDENTIFICATION	VARIANCE	SD	SEM	C.V. %
1	Control	0.0515	0.2269	0.1135	5.6979
2	APG-02	2.5408	1.5940	0.7970	31.0569
3	APG-06	0.0372	0.1929	0.0965	7.2194
4	APG-16	0.1225	0.3500	0.1750	20.7400
5	APG-15	0.0873	0.2955	0.1477	18.0428

Toxstat Version 3.5 Page____of_____
Study # 60147216-445-(035-038)
ESTCP
Echinochloa crusgalli
Analysis of for Nutrient Uptake Factor: BORON using Lab Control

JK 12/13/12
QA: a 12/13/12

```
  Title:  60225262-445-(035-038)
  File:       445boro.dat            Transform:            LOG BASE 10(Y)

                    Shapiro - Wilk's Test for Normality
  ---------------------------------------------------------------------------

     D =   0.0972
     W =   0.9689

     Critical W  = 0.8680 (alpha = 0.01 , N = 20)
              W  = 0.9050 (alpha = 0.05 , N = 20)

  ---------------------------------------------------------------------------
  Data PASS normality test (alpha = 0.01). Continue analysis.


  Title:  60225262-445-(035-038)
  File:       445boro.dat            Transform:            LOG BASE 10(Y)

                 Bartlett's Test for Homogeneity of Variance
  ---------------------------------------------------------------------------

  Calculated B1 statistic =  8.0141              (p-value = 0.0911)

  Data PASS B1 homogeneity test at 0.01 level. Continue analysis.
  ---------------------------------------------------------------------------

  Critical B = 13.2767  (alpha = 0.01, df =  4)
             =  9.4877  (alpha = 0.05, df =  4)
```

Toxstat Version 3.5 Page____of_____
Study # 60147216-445-(035-038)
ESTCP
Echinochloa crusgalli
Analysis of Nutrient Uptake Factor: BORON using Lab Control

QA:CU 12/13/12
12/13/12

Title: 60225262-445-(035-038)
File: 445boro.dat Transform: LOG BASE 10(Y)

ANOVA Table

SOURCE	DF	SS	MS	F
Between	4	0.7731	0.1933	29.8322
Within (Error)	15	0.0972	0.0065	
Total	19	0.8702		

(p-value = 0.0000)

Critical F = 4.8932 (alpha = 0.01, df = 4,15)
= 3.0556 (alpha = 0.05, df = 4,15)

Since F > Critical F REJECT Ho: All equal (alpha = 0.05)

Title: 60225262-445-(035-038)
File: 445boro.dat Transform: LOG BASE 10(Y)

Dunnett's Test - TABLE 1 OF 2 Ho:Control=Treatment

GROUP	IDENTIFICATION	TRANSFORMED MEAN	MEAN CALCULATED IN ORIGINAL UNITS	TRANS T STAT	SIG 0.05
1	Control	0.5996	3.9825		
2	APG-02	0.6967	5.1325	1.7054	
3	APG-06	0.4261	2.6725	3.0495	*
4	APG-16	0.2195	1.6875	6.6786	*
5	APG-15	0.2085	1.6375	6.8718	*

Dunnett critical value = 2.7300 (2 Tailed, alpha = 0.05, df = 4,15)

Title: 60225262-445-(035-038)
File: 445boro.dat Transform: LOG BASE 10(Y)

Dunnett's Test - TABLE 2 OF 2 Ho:Control=Treatment

GROUP	IDENTIFICATION	NUM OF REPS	MIN SIG DIFF (IN ORIG. UNITS)	% OF CONTROL	DIFFERENCE FROM CONTROL
1	Control	4			
2	APG-02	4	1.1963	30.1	1.1500
3	APG-06	4	1.1963	30.1	1.3100
4	APG-16	4	1.1963	30.1	2.2950
5	APG-15	4	1.1963	30.1	2.3450

Toxstat Version 3.5 Page____of____
Study # 60147216-445-(035-038)
ESTCP QA:cw 12/13/12
Echinochloa crusgalli 12/13/12
Summary Statistics for Nutrient Uptake Factor: CALCIUM using Lab Control

Title: 60225262-45-(035-038)
File: 445calci.dat Transform: NO TRANSFORMATION

Summary Statistics on Data TABLE 1 of 2

GRP	IDENTIFICATION	N	MIN	MAX	MEAN
1	Control	4	2.1800	3.0500	2.5975
2	APG-02	4	3.1200	10.3000	5.0225
3	APG-06	4	1.3900	3.7100	2.0825
4	APG-16	4	3.0700	3.3700	3.2250
5	APG-15	4	0.7230	1.4900	1.0875

Title: 60225262-45-(035-038)
File: 445calci.dat Transform: NO TRANSFORMATION

Summary Statistics on Data TABLE 2 of 2

GRP	IDENTIFICATION	VARIANCE	SD	SEM	C.V. %
1	Control	0.1272	0.3566	0.1783	13.7283
2	APG-02	12.3891	3.5198	1.7599	70.0809
3	APG-06	1.2113	1.1006	0.5503	52.8493
4	APG-16	0.0193	0.1389	0.0695	4.3077
5	APG-15	0.1477	0.3843	0.1921	35.3361

Toxstat Version 3.5
Study # 60147216-445-(035-038)
ESTCP
Echinochloa crusgalli
Analysis of Nutrient Uptake Factor: CALCIUM using Lab Control

Page____of____
QA: cw 12/13/12
12/13/12

```
  Title:  60225262-45-(035-038)
  File:      445calci.dat            Transform:          1/SQUARE ROOT(Y+0.5)

                     Shapiro - Wilk's Test for Normality
  ----------------------------------------------------------------------------

       D =    0.1036
       W =    0.9006

       Critical W  = 0.8680 (alpha = 0.01 , N = 20)
                W  = 0.9050 (alpha = 0.05 , N = 20)

  ----------------------------------------------------------------------------
  Data PASS normality test (alpha = 0.01). Continue analysis.


  Title:  60225262-45-(035-038)
  File:      445calci.dat            Transform:          1/SQUARE ROOT(Y+0.5)

                  Bartlett's Test for Homogeneity of Variance
  ----------------------------------------------------------------------------

  Calculated B1 statistic = 12.5602              (p-value = 0.0136)

  Data PASS B1 homogeneity test at 0.01 level. Continue analysis.
  ----------------------------------------------------------------------------

  Critical B = 13.2767  (alpha = 0.01, df =  4)
             =  9.4877  (alpha = 0.05, df =  4)
```

Toxstat Version 3.5 Page_____of____
Study # 60147216-445-(035-038)
ESTCP
Echinochloa crusgalli
Analysis of Nutrient Uptake Factor: CALCIUM using Lab Control

12/13/12
QA: CW 12/13/12

Title: 60225262-45-(035-038)
File: 445calci.dat Transform: 1/SQUARE ROOT(Y+0.5)

ANOVA Table

SOURCE	DF	SS	MS	F
Between	4	0.2864	0.0716	10.3731
Within (Error)	15	0.1036	0.0069	
Total	19	0.3900		

(p-value = 0.0003)

Critical F = 4.8932 (alpha = 0.01, df = 4,15)
= 3.0556 (alpha = 0.05, df = 4,15)

Since F > Critical F REJECT Ho: All equal (alpha = 0.05)

Title: 60225262-45-(035-038)
File: 445calci.dat Transform: 1/SQUARE ROOT(Y+0.5)

Dunnett's Test - TABLE 1 OF 2 Ho:Control=Treatment

GROUP	IDENTIFICATION	TRANSFORMED MEAN	MEAN CALCULATED IN ORIGINAL UNITS	TRANS T STAT	SIG 0.05
1	Control	0.5703	2.5975		
2	APG-02	0.4628	5.0225	1.8300	
3	APG-06	0.6485	2.0825	1.3307	
4	APG-16	0.5183	3.2250	0.8847	
5	APG-15	0.8071	1.0875	4.0304	*

Dunnett critical value = 2.7300 (2 Tailed, alpha = 0.05, df = 4,15)

Title: 60225262-45-(035-038)
File: 445calci.dat Transform: 1/SQUARE ROOT(Y+0.5)

Dunnett's Test - TABLE 2 OF 2 Ho:Control=Treatment

GROUP	IDENTIFICATION	NUM OF REPS	MIN SIG DIFF (IN ORIG. UNITS)	% OF CONTROL	DIFFERENCE FROM CONTROL
1	Control	4			
2	APG-02	4	1.2016	33.6	2.4250
3	APG-06	4	1.2016	33.6	0.5150
4	APG-16	4	1.2016	33.6	0.6275
5	APG-15	4	1.2016	33.6	1.5100

Toxstat Version 3.5 Page____of____
Study # 60147216-445-(035-038)
ESTCP
Echinochloa crusgalli
Summary Statistics for Nutrient Uptake Factor: COPPER using Lab Control

AK 12/13/12
QA: CW 12/13/12

Title: 60225262-445-(035-038)
File: 445coppe.dat Transform: NO TRANSFORMATION

Summary Statistics on Data TABLE 1 of 2

GRP	IDENTIFICATION	N	MIN	MAX	MEAN
1	Control	4	1.3800	2.2300	1.7500
2	APG-02	4	0.0540	0.1100	0.0845
3	APG-06	4	0.0750	0.1280	0.0995
4	APG-16	4	0.0220	0.0270	0.0245
5	APG-15	4	0.0130	0.0280	0.0178

Title: 60225262-445-(035-038)
File: 445coppe.dat Transform: NO TRANSFORMATION

Summary Statistics on Data TABLE 2 of 2

GRP	IDENTIFICATION	VARIANCE	SD	SEM	C.V. %
1	Control	0.1405	0.3748	0.1874	21.4165
2	APG-02	0.0008	0.0282	0.0141	33.4237
3	APG-06	0.0005	0.0222	0.0111	22.3303
4	APG-16	0.0000	0.0024	0.0012	9.7162
5	APG-15	0.0000	0.0069	0.0035	39.1336

Toxstat Version 3.5 Page____of_____
Study # 60147216-445-(035-038)
ESTCP
Echinochloa crusgalli
Analysis of Nutrient Uptake Factor: COPPER using Lab Control

de12|13|12
QA: CW 12|13|12

```
Title:  60225262-445-(035-038)
File:      445coppe.dat              Transform:              LOG BASE 10(Y)

                 Shapiro - Wilk's Test for Normality
---------------------------------------------------------------------------

     D =    0.1971
     W =    0.9657

     Critical W  = 0.8680 (alpha = 0.01 , N = 20)
              W  = 0.9050 (alpha = 0.05 , N = 20)

---------------------------------------------------------------------------

Data PASS normality test (alpha = 0.01). Continue analysis.


Title:  60225262-445-(035-038)
File:      445coppe.dat              Transform:              LOG BASE 10(Y)

              Bartlett's Test for Homogeneity of Variance
---------------------------------------------------------------------------

Calculated B1 statistic =  4.3735             (p-value = 0.3578)

Data PASS B1 homogeneity test at 0.01 level. Continue analysis.

---------------------------------------------------------------------------

Critical B = 13.2767  (alpha = 0.01, df =  4)
           =  9.4877  (alpha = 0.05, df =  4)
```

Toxstat Version 3.5 Page____of____
Study # 60147216-445-(035-038)
ESTCP
Echinochloa crusgalli
Analysis of Nutrient Uptake Factor: COPPER using Lab Control

de 12/13/12
QA: CW 12/13/12

Title: 60225262-445-(035-038)
File: 445coppe.dat Transform: LOG BASE 10(Y)

ANOVA Table

SOURCE	DF	SS	MS	F
Between	4	9.9770	2.4943	189.8289
Within (Error)	15	0.1971	0.0131	
Total	19	10.1741		

(p-value = 0.0000)

Critical F = 4.8932 (alpha = 0.01, df = 4,15)
= 3.0556 (alpha = 0.05, df = 4,15)

Since F > Critical F REJECT Ho: All equal (alpha = 0.05)

Title: 60225262-445-(035-038)
File: 445coppe.dat Transform: LOG BASE 10(Y)

Dunnett's Test - TABLE 1 OF 2 Ho:Control=Treatment

GROUP	IDENTIFICATION	TRANSFORMED MEAN	MEAN CALCULATED IN ORIGINAL UNITS	TRANS T STAT	SIG 0.05
1	Control	0.2357	1.7500		
2	APG-02	-1.0927	0.0845	16.3892	*
3	APG-06	-1.0103	0.0995	15.3724	*
4	APG-16	-1.6124	0.0245	22.8008	*
5	APG-15	-1.7722	0.0178	24.7721	*

Dunnett critical value = 2.7300 (2 Tailed, alpha = 0.05, df = 4,15)

Title: 60225262-445-(035-038)
File: 445coppe.dat Transform: LOG BASE 10(Y)

Dunnett's Test - TABLE 2 OF 2 Ho:Control=Treatment

GROUP	IDENTIFICATION	NUM OF REPS	MIN SIG DIFF (IN ORIG. UNITS)	% OF CONTROL	DIFFERENCE FROM CONTROL
1	Control	4			
2	APG-02	4	0.6869	39.9	1.6655
3	APG-06	4	0.6869	39.9	1.6505
4	APG-16	4	0.6869	39.9	1.7255
5	APG-15	4	0.6869	39.9	1.7322

Toxstat Version 3.5
Study # 60147216-445-(035-038)
ESTCP
Echinochloa crusgalli
Summary Statistics for Nutrient Uptake Factor: IRON using Lab Control

Page____of_____

ck 12|13|12
QA:cw 12|13|12

Title: 60225262-445-(035-038)
File: 445iro.dat Transform: NO TRANSFORMATION

Summary Statistics on Data TABLE 1 of 2

GRP	IDENTIFICATION	N	MIN	MAX	MEAN
1	Control	4	0.0660	0.1030	0.0823
2	APG-02	4	0.0060	0.0280	0.0170
3	APG-06	4	0.0100	0.0220	0.0138
4	APG-16	4	0.0020	0.0090	0.0053
5	APG-15	4	0.0030	0.0100	0.0058

Title: 60225262-445-(035-038)
File: 445iro.dat Transform: NO TRANSFORMATION

Summary Statistics on Data TABLE 2 of 2

GRP	IDENTIFICATION	VARIANCE	SD	SEM	C.V. %
1	Control	0.0002	0.0153	0.0077	18.6611
2	APG-02	0.0001	0.0106	0.0053	62.6224
3	APG-06	0.0000	0.0057	0.0028	41.3012
4	APG-16	0.0000	0.0030	0.0015	56.8777
5	APG-15	0.0000	0.0030	0.0015	51.9318

Toxstat Version 3.5 Page____of_____
Study # 60147216-445-(035-038)
ESTCP
Echinochloa crusgalli
Analysis of Nutrient Uptake Factor: IRON using Lab Control

*12/13/12
QA:CW 12/13/12

Title: 60225262-445-(035-038)
File: 445iro.dat Transform: NO TRANSFORMATION

Shapiro - Wilk's Test for Normality

D = 0.0012
W = 0.9427

Critical W = 0.8680 (alpha = 0.01 , N = 20)
W = 0.9050 (alpha = 0.05 , N = 20)

Data PASS normality test (alpha = 0.01). Continue analysis.

Title: 60225262-445-(035-038)
File: 445iro.dat Transform: NO TRANSFORMATION

Bartlett's Test for Homogeneity of Variance

Calculated B1 statistic = 10.2067 (p-value = 0.0371)

Data PASS B1 homogeneity test at 0.01 level. Continue analysis.

Critical B = 13.2767 (alpha = 0.01, df = 4)
= 9.4877 (alpha = 0.05, df = 4)

Toxstat Version 3.5 Page____of_____
Study # 60147216-445-(035-038)
ESTCP
Echinochloa crusgalli
Analysis of Nutrient Uptake Factor: IRON using Lab Control

12/13/12
QA: 12/13/12

Title: 60225262-445-(035-038)
File: 445iro.dat Transform: NO TRANSFORMATION

ANOVA Table

SOURCE	DF	SS	MS	F
Between	4	0.0169	0.0042	52.9893
Within (Error)	15	0.0012	0.0001	
Total	19	0.0181		

(p-value = 0.0000)

Critical F = 4.8932 (alpha = 0.01, df = 4,15)
= 3.0556 (alpha = 0.05, df = 4,15)

Since F > Critical F REJECT Ho: All equal (alpha = 0.05)

Title: 60225262-445-(035-038)
File: 445iro.dat Transform: NO TRANSFORMATION

Dunnett's Test - TABLE 1 OF 2 Ho:Control=Treatment

GROUP	IDENTIFICATION	TRANSFORMED MEAN	MEAN CALCULATED IN ORIGINAL UNITS	T STAT	SIG 0.05
1	Control	0.0823	0.0823		
2	APG-02	0.0170	0.0170	10.3299	*
3	APG-06	0.0138	0.0138	10.8444	*
4	APG-16	0.0053	0.0053	12.1900	*
5	APG-15	0.0058	0.0058	12.1109	*

Dunnett critical value = 2.7300 (2 Tailed, alpha = 0.05, df = 4,15)

Title: 60225262-445-(035-038)
File: 445iro.dat Transform: NO TRANSFORMATION

Dunnett's Test - TABLE 2 OF 2 Ho:Control=Treatment

GROUP	IDENTIFICATION	NUM OF REPS	MIN SIG DIFF (IN ORIG. UNITS)	% OF CONTROL	DIFFERENCE FROM CONTROL
1	Control	4			
2	APG-02	4	0.0172	21.0	0.0653
3	APG-06	4	0.0172	21.0	0.0685
4	APG-16	4	0.0172	21.0	0.0770
5	APG-15	4	0.0172	21.0	0.0765

Toxstat Version 3.5 Page____of______
Study # 60147216-445-(035-038)
ESTCP
Echinochloa crusgalli
Summary Statistics for Nutrient Uptake Factor: MAGNESIUM using Lab Control

QA:cw 12/13/12
12/13/12

Title: 60225262-445-(035-038)
File: 445mag.dat Transform: NO TRANSFORMATION

Summary Statistics on Data TABLE 1 of 2

GRP	IDENTIFICATION	N	MIN	MAX	MEAN
1	Control	4	107.0000	131.0000	114.7500
2	APG-02	4	7.8700	9.4900	8.7525
3	APG-06	4	2.9000	3.8300	3.5825
4	APG-16	4	2.9400	3.5000	3.1425
5	APG-15	4	1.7200	1.9300	1.8550

Title: 60225262-445-(035-038)
File: 445mag.dat Transform: NO TRANSFORMATION

Summary Statistics on Data TABLE 2 of 2

GRP	IDENTIFICATION	VARIANCE	SD	SEM	C.V. %
1	Control	121.5833	11.0265	5.5132	9.6091
2	APG-02	0.6212	0.7882	0.3941	9.0052
3	APG-06	0.2072	0.4552	0.2276	12.7068
4	APG-16	0.0631	0.2512	0.1256	7.9930
5	APG-15	0.0090	0.0947	0.0473	5.1047

Toxstat Version 3.5 Page____of_____
Study # 60147216-445-(035-038)
ESTCP
Echinochloa crusgalli
Analysis of Nutrient Uptake Factor: MAGNESIUM using Lab Control

de 12/13/12
QA: cw 12/13/12

```
Title:  60225262-445-(035-038)
File:        445mag.dat            Transform:              LOG BASE 10(Y)

                Shapiro - Wilk's Test for Normality
-----------------------------------------------------------------------------

     D =    0.0250
     W =    0.9607

     Critical W  = 0.8680 (alpha = 0.01 , N = 20)
              W  = 0.9050 (alpha = 0.05 , N = 20)

-----------------------------------------------------------------------------

Data PASS normality test (alpha = 0.01). Continue analysis.


Title:  60225262-445-(035-038)
File:        445mag.dat            Transform:              LOG BASE 10(Y)

             Bartlett's Test for Homogeneity of Variance
-----------------------------------------------------------------------------

Calculated B1 statistic =  2.4257              (p-value = 0.6580)

Data PASS B1 homogeneity test at 0.01 level. Continue analysis.

-----------------------------------------------------------------------------

Critical B = 13.2767  (alpha = 0.01, df =  4)
           =  9.4877  (alpha = 0.05, df =  4)
```

Toxstat Version 3.5 Page____of______
Study # 60147216-445-(035-038)
ESTCP
Echinochloa crusgalli
Analysis of Nutrient Uptake Factor: MAGNESIUM using Lab Control

de 12/13/12
QA: CW 12/13/12

Title: 60225262-445-(035-038)
File: 445mag.dat Transform: LOG BASE 10(Y)

ANOVA Table

SOURCE	DF	SS	MS	F
Between	4	8.0826	2.0206	1212.2158
Within (Error)	15	0.0250	0.0017	
Total	19	8.1076		

(p-value = 0.0000)

Critical F = 4.8932 (alpha = 0.01, df = 4,15)
= 3.0556 (alpha = 0.05, df = 4,15)

Since F > Critical F REJECT Ho: All equal (alpha = 0.05)

Title: 60225262-445-(035-038)
File: 445mag.dat Transform: LOG BASE 10(Y)

Dunnett's Test - TABLE 1 OF 2 Ho:Control=Treatment

GROUP	IDENTIFICATION	TRANSFORMED MEAN	MEAN CALCULATED IN ORIGINAL UNITS	TRANS T STAT	SIG 0.05
1	Control	2.0583	114.7500		
2	APG-02	0.9408	8.7525	38.7096	*
3	APG-06	0.5513	3.5825	52.2015	*
4	APG-16	0.4963	3.1425	54.1074	*
5	APG-15	0.2679	1.8550	62.0175	*

Dunnett critical value = 2.7300 (2 Tailed, alpha = 0.05, df = 4,15)

Title: 60225262-445-(035-038)
File: 445mag.dat Transform: LOG BASE 10(Y)

Dunnett's Test - TABLE 2 OF 2 Ho:Control=Treatment

GROUP	IDENTIFICATION	NUM OF REPS	MIN SIG DIFF (IN ORIG. UNITS)	% OF CONTROL	DIFFERENCE FROM CONTROL
1	Control	4			
2	APG-02	4	18.9816	16.6	105.9975
3	APG-06	4	18.9816	16.6	111.1675
4	APG-16	4	18.9816	16.6	111.6075
5	APG-15	4	18.9816	16.6	112.8950

Toxstat Version 3.5 Page____of_____
Study # 60147216-445-(035-038)
ESTCP
Echinochloa crusgalli
Summary Statistics for Nutrient Uptake Factor: Manganese using Lab Control

QA:Q 12\13\12
CP 12\13\12

Title: 60225262-445-(035-038)
File: 445man.dat Transform: NO TRANSFORMATION

Summary Statistics on Data TABLE 1 of 2

GRP	IDENTIFICATION	N	MIN	MAX	MEAN
1	Control	4	16.4000	25.8000	20.1500
2	APG-02	4	4.5800	9.3700	6.8850
3	APG-06	4	0.6990	3.4000	1.7023
4	APG-16	4	0.8090	2.2000	1.6923
5	APG-15	4	1.0100	1.4700	1.2550

Title: 60225262-445-(035-038)
File: 445man.dat Transform: NO TRANSFORMATION

Summary Statistics on Data TABLE 2 of 2

GRP	IDENTIFICATION	VARIANCE	SD	SEM	C.V. %
1	Control	16.2567	4.0320	2.0160	20.0097
2	APG-02	5.0408	2.2452	1.1226	32.6097
3	APG-06	1.4347	1.1978	0.5989	70.3649
4	APG-16	0.3865	0.6217	0.3109	36.7398
5	APG-15	0.0358	0.1893	0.0946	15.0834

Study # 60147216-445-(035-038)
ESTCP
Echinochloa crusgalli
Analysis of Nutrient Uptake Factor: Manganese using Lab Control 12/13/12
QA: CW 12/13/12

Title: 60225262-445-(035-038)
File: 445man.dat Transform: LOG BASE 10(Y)

Shapiro - Wilk's Test for Normality

D = 0.4758
W = 0.9633

Critical W = 0.8680 (alpha = 0.01 , N = 20)
W = 0.9050 (alpha = 0.05 , N = 20)

Data PASS normality test (alpha = 0.01). Continue analysis.

Title: 60225262-445-(035-038)
File: 445man.dat Transform: LOG BASE 10(Y)

Bartlett's Test for Homogeneity of Variance

Calculated B1 statistic = 6.9888 (p-value = 0.1365)

Data PASS B1 homogeneity test at 0.01 level. Continue analysis.

Critical B = 13.2767 (alpha = 0.01, df = 4)
= 9.4877 (alpha = 0.05, df = 4)

Toxstat Version 3.5 Page____of_____
Study # 60147216-445-(035-038)
ESTCP
Echinochloa crusgalli
Analysis of Nutrient Uptake Factor: Manganese using Lab Control

12|13|12
QA:CU 12\13\12

Title: 60225262-445-(035-038)
File: 445man.dat Transform: LOG BASE 10(Y)

ANOVA Table

SOURCE	DF	SS	MS	F
Between	4	4.4503	1.1126	35.0773
Within (Error)	15	0.4758	0.0317	
Total	19	4.9260		

(p-value = 0.0000)

Critical F = 4.8932 (alpha = 0.01, df = 4,15)
= 3.0556 (alpha = 0.05, df = 4,15)

Since F > Critical F REJECT Ho: All equal (alpha = 0.05)

Title: 60225262-445-(035-038)
File: 445man.dat Transform: LOG BASE 10(Y)

Dunnett's Test - TABLE 1 OF 2 Ho:Control=Treatment

GROUP	IDENTIFICATION	TRANSFORMED MEAN	MEAN CALCULATED IN ORIGINAL UNITS	TRANS T STAT	SIG 0.05
1	Control	1.2981	20.1500		
2	APG-02	0.8199	6.8850	3.7974	*
3	APG-06	0.1547	1.7023	9.0798	*
4	APG-16	0.1989	1.6923	8.7288	*
5	APG-15	0.0948	1.2550	9.5555	*

Dunnett critical value = 2.7300 (2 Tailed, alpha = 0.05, df = 4,15)

Title: 60225262-445-(035-038)
File: 445man.dat Transform: LOG BASE 10(Y)

Dunnett's Test - TABLE 2 OF 2 Ho:Control=Treatment

GROUP	IDENTIFICATION	NUM OF REPS	MIN SIG DIFF (IN ORIG. UNITS)	% OF CONTROL	DIFFERENCE FROM CONTROL
1	Control	4			
2	APG-02	4	10.8648	54.7	13.2650
3	APG-06	4	10.8648	54.7	18.4478
4	APG-16	4	10.8648	54.7	18.4578
5	APG-15	4	10.8648	54.7	18.8950

Page — of —
~~Page o~~ (1)
QA:OU 12/14/12
12/13/12

Toxstat Version 3.5
Study # 60147216-445-(035-038)
ESTCP
Echinochloa crusgalli
Summary Statistics for Nutrient Uptake Factor: PHOSPHORUS using Lab Control

Title: 60225262-445-(035-038)
File: 445ph.dat Transform: NO TRANSFORMATION

Summary Statistics on Data TABLE 1 of 2

GRP	IDENTIFICATION	N	MIN	MAX	MEAN
1	Control	4	16.4000	21.2000	19.3000
2	APG-02	4	2.3700	3.2900	2.8475
3	APG-06	4	3.7300	4.5600	4.0375
4	APG-16	4	1.8000	2.5900	2.1975
5	APG-15	4	1.6500	1.9900	1.8250

Title: 60225262-445-(035-038)
File: 445ph.dat Transform: NO TRANSFORMATION

Summary Statistics on Data TABLE 2 of 2

GRP	IDENTIFICATION	VARIANCE	SD	SEM	C.V. %
1	Control	5.3000	2.3022	1.1511	11.9284
2	APG-02	0.1415	0.3762	0.1881	13.2100
3	APG-06	0.1303	0.3610	0.1805	8.9402
4	APG-16	0.1051	0.3242	0.1621	14.7521
5	APG-15	0.0306	0.1748	0.0874	9.5799

(1) 12/13/12,B

Toxstat Version 3.5
Study # 60147216-445-(035-038)
ESTCP
Echinochloa crusgalli
Analysis of Nutrient Uptake Factor: PHOSPHORUS using Lab Control

Page __ of __

12/13/12
QA: 12/14/12

Title: 60225262-445-(035-038)
File: 445ph.dat Transform: LOG BASE 10(Y)

Shapiro - Wilk's Test for Normality

D = 0.0409
W = 0.9660

Critical W = 0.8680 (alpha = 0.01 , N = 20)
W = 0.9050 (alpha = 0.05 , N = 20)

Data PASS normality test (alpha = 0.01). Continue analysis.

Title: 60225262-445-(035-038)
File: 445ph.dat Transform: LOG BASE 10(Y)

Bartlett's Test for Homogeneity of Variance

Calculated B1 statistic = 1.0626 (p-value = 0.9002)

Data PASS B1 homogeneity test at 0.01 level. Continue analysis.

Critical B = 13.2767 (alpha = 0.01, df = 4)
= 9.4877 (alpha = 0.05, df = 4)

Toxstat Version 3.5
Study # 60147216-445-(035-038)
ESTCP
Echinochloa crusgalli
Analysis of Nutrient Uptake Factor: PHOSPHORUS using Lab Control

Page ___ of ___

12/13/12
QA:CU 12/14/12

Title: 60225262-445-(035-038)
File: 445ph.dat Transform: LOG BASE 10(Y)

ANOVA Table

SOURCE	DF	SS	MS	F
Between	4	2.6889	0.6722	246.5160
Within (Error)	15	0.0409	0.0027	
Total	19	2.7298		

(p-value = 0.0000)

Critical F = 4.8932 (alpha = 0.01, df = 4,15)
= 3.0556 (alpha = 0.05, df = 4,15)

Since F > Critical F REJECT Ho: All equal (alpha = 0.05)

Title: 60225262-445-(035-038)
File: 445ph.dat Transform: LOG BASE 10(Y)

Dunnett's Test - TABLE 1 OF 2 Ho:Control=Treatment

GROUP	IDENTIFICATION	TRANSFORMED MEAN	MEAN CALCULATED IN ORIGINAL UNITS	TRANS T STAT	SIG 0.05
1	Control	1.2832	19.3000		
2	APG-02	0.4515	2.8475	22.5216	*
3	APG-06	0.6049	4.0375	18.3695	*
4	APG-16	0.3383	2.1975	25.5880	*
5	APG-15	0.2598	1.8250	27.7155	*

Dunnett critical value = 2.7300 (2 Tailed, alpha = 0.05, df = 4,15)

Title: 60225262-445-(035-038)
File: 445ph.dat Transform: LOG BASE 10(Y)

Dunnett's Test - TABLE 2 OF 2 Ho:Control=Treatment

GROUP	IDENTIFICATION	NUM OF REPS	MIN SIG DIFF (IN ORIG. UNITS)	% OF CONTROL	DIFFERENCE FROM CONTROL
1	Control	4			
2	APG-02	4	3.9758	20.7	16.4525
3	APG-06	4	3.9758	20.7	15.2625
4	APG-16	4	3.9758	20.7	17.1025
5	APG-15	4	3.9758	20.7	17.4750

Toxstat Version 3.5
Study # 60147216-445-(035-038)
ESTCP
Echinochloa crusgalli
Summary Statistics for Nutrient Uptake Factor: POTASSIUM using Lab Control

Page____of_____

QA: CW 12/13/12
12/13/12

Title: 60225262-445-(035-038)
File: 445pota.dat Transform: NO TRANSFORMATION

Summary Statistics on Data TABLE 1 of 2

GRP	IDENTIFICATION	N	MIN	MAX	MEAN
1	Control	4	113.0000	148.0000	124.0000
2	APG-02	4	50.7000	62.2000	56.6250
3	APG-06	4	54.3000	65.5000	59.1500
4	APG-16	4	20.8000	31.0000	26.6000
5	APG-15	4	26.4000	33.8000	30.8750

Title: 60225262-445-(035-038)
File: 445pota.dat Transform: NO TRANSFORMATION

Summary Statistics on Data TABLE 2 of 2

GRP	IDENTIFICATION	VARIANCE	SD	SEM	C.V. %
1	Control	262.0000	16.1864	8.0932	13.0536
2	APG-02	24.7492	4.9749	2.4874	8.7856
3	APG-06	32.8633	5.7327	2.8663	9.6917
4	APG-16	25.7000	5.0695	2.5348	19.0583
5	APG-15	11.5292	3.3955	1.6977	10.9974

Toxstat Version 3.5 Page____of_____
Study # 60147216-445-(035-038)
ESTCP
Echinochloa crusgalli
Analysis of Nutrient Uptake Factor: POTASSIUM using Lab Control

12/13/12
QA:CW 12/13/12

Title: 60225262-445-(035-038)
File: 445pota.dat Transform: LOG BASE 10(Y)

Shapiro - Wilk's Test for Normality

D = 0.0474
W = 0.9589

Critical W = 0.8680 (alpha = 0.01 , N = 20)
W = 0.9050 (alpha = 0.05 , N = 20)

Data PASS normality test (alpha = 0.01). Continue analysis.

Title: 60225262-445-(035-038)
File: 445pota.dat Transform: LOG BASE 10(Y)

Bartlett's Test for Homogeneity of Variance

Calculated B1 statistic = 2.2972 (p-value = 0.6813)

Data PASS B1 homogeneity test at 0.01 level. Continue analysis.

Critical B = 13.2767 (alpha = 0.01, df = 4)
= 9.4877 (alpha = 0.05, df = 4)

Toxstat Version 3.5 Page____of_____
Study # 60147216-445-(035-038)
ESTCP
Echinochloa crusgalli
Analysis of Nutrient Uptake Factor: POTASSIUM using Lab Control

QA:CW 12\13\12
12|13|12

Title: 60225262-445-(035-038)
File: 445pota.dat Transform: LOG BASE 10(Y)

ANOVA Table

SOURCE	DF	SS	MS	F
Between	4	1.1382	0.2846	90.1163
Within (Error)	15	0.0474	0.0032	
Total	19	1.1856		

(p-value = 0.0000)

Critical F = 4.8932 (alpha = 0.01, df = 4,15)
= 3.0556 (alpha = 0.05, df = 4,15)

Since F > Critical F REJECT Ho: All equal (alpha = 0.05)

Title: 60225262-445-(035-038)
File: 445pota.dat Transform: LOG BASE 10(Y)

Dunnett's Test - TABLE 1 OF 2 Ho:Control=Treatment

GROUP	IDENTIFICATION	TRANSFORMED MEAN	MEAN CALCULATED IN ORIGINAL UNITS	TRANS T STAT	SIG 0.05
1	Control	2.0908	124.0000		
2	APG-02	1.7517	56.6250	8.5341	*
3	APG-06	1.7704	59.1500	8.0637	*
4	APG-16	1.4187	26.6000	16.9147	*
5	APG-15	1.4876	30.8750	15.1828	*

Dunnett critical value = 2.7300 (2 Tailed, alpha = 0.05, df = 4,15)

Title: 60225262-445-(035-038)
File: 445pota.dat Transform: LOG BASE 10(Y)

Dunnett's Test - TABLE 2 OF 2 Ho:Control=Treatment

GROUP	IDENTIFICATION	NUM OF REPS	MIN SIG DIFF (IN ORIG. UNITS)	% OF CONTROL	DIFFERENCE FROM CONTROL
1	Control	4			
2	APG-02	4	27.2441	22.1	67.3750
3	APG-06	4	27.2441	22.1	64.8500
4	APG-16	4	27.2441	22.1	97.4000
5	APG-15	4	27.2441	22.1	93.1250

Toxstat Version 3.5 Page____of____
Study # 60147216-445-(035-038)
ESTCP
Echinochloa crusgalli
Summary Statistics for Nutrient Uptake Factor: SODIUM using Lab Control

12/13/12
12/13/12

Title: 60225262-445-(035*-038)
File: 445sodi.dat Transform: NO TRANSFORMATION

Summary Statistics on Data TABLE 1 of 2

GRP	IDENTIFICATION	N	MIN	MAX	MEAN
1	Control	4	2.7200	3.9900	3.1900
2	APG-02	4	7.8200	51.7000	21.3050
3	APG-06	4	7.3400	40.4000	23.2850
4	APG-16	4	11.3000	17.8000	15.4500
5	APG-15	4	14.2000	45.5000	25.1000

Title: 60225262-445-(035*-038)
File: 445sodi.dat Transform: NO TRANSFORMATION

Summary Statistics on Data TABLE 2 of 2

GRP	IDENTIFICATION	VARIANCE	SD	SEM	C.V. %
1	Control	0.3255	0.5706	0.2853	17.8857
2	APG-02	420.9068	20.5160	10.2580	96.2967
3	APG-06	203.5236	14.2662	7.1331	61.2676
4	APG-16	8.3233	2.8850	1.4425	18.6733
5	APG-15	197.7000	14.0606	7.0303	56.0183

Toxstat Version 3.5 Page____of____
Study # 60147216-445-(035-038)
ESTCP
Echinochloa crusgalli
Analysis of Nutrient Uptake Factor: SODIUM using Lab Control

de 12|13|12
QA:CW 12\13\12

Title: 60225262-445-(035*-038)
File: 445sodi.dat Transform: LOG BASE 10(Y)

Shapiro - Wilk's Test for Normality

D = 0.8882
W = 0.9700

Critical W = 0.8680 (alpha = 0.01 , N = 20)
W = 0.9050 (alpha = 0.05 , N = 20)

Data PASS normality test (alpha = 0.01). Continue analysis.

Title: 60225262-445-(035*-038)
File: 445sodi.dat Transform: LOG BASE 10(Y)

Bartlett's Test for Homogeneity of Variance

Calculated B1 statistic = 8.5935 (p-value = 0.0721)

Data PASS B1 homogeneity test at 0.01 level. Continue analysis.

Critical B = 13.2767 (alpha = 0.01, df = 4)
= 9.4877 (alpha = 0.05, df = 4)

Toxstat Version 3.5 Page____of____
Study # 60147216-445-(035-038)
ESTCP
Echinochloa crusgalli
Analysis of Nutrient Uptake Factor: SODIUM using Lab Control

dk 12/13/12
QA: cw 12/13/12

Title: 60225262-445-(035*-038)
File: 445sodi.dat Transform: LOG BASE 10(Y)

ANOVA Table

SOURCE	DF	SS	MS	F
Between	4	1.9167	0.4792	8.0929
Within (Error)	15	0.8882	0.0592	
Total	19	2.8049		

(p-value = 0.0011)

Critical F = 4.8932 (alpha = 0.01, df = 4,15)
= 3.0556 (alpha = 0.05, df = 4,15)

Since F > Critical F REJECT Ho: All equal (alpha = 0.05)

Title: 60225262-445-(035*-038)
File: 445sodi.dat Transform: LOG BASE 10(Y)

Dunnett's Test - TABLE 1 OF 2 Ho:Control=Treatment

GROUP	IDENTIFICATION	TRANSFORMED MEAN	MEAN CALCULATED IN ORIGINAL UNITS	TRANS T STAT	SIG 0.05
1	Control	0.4989	3.1900		
2	APG-02	1.2014	21.3050	4.0830	*
3	APG-06	1.2892	23.2850	4.5933	*
4	APG-16	1.1825	15.4500	3.9731	*
5	APG-15	1.3551	25.1000	4.9764	*

Dunnett critical value = 2.7300 (2 Tailed, alpha = 0.05, df = 4,15)

Title: 60225262-445-(035*-038)
File: 445sodi.dat Transform: LOG BASE 10(Y)

Dunnett's Test - TABLE 2 OF 2 Ho:Control=Treatment

GROUP	IDENTIFICATION	NUM OF REPS	MIN SIG DIFF (IN ORIG. UNITS)	% OF CONTROL	DIFFERENCE FROM CONTROL
1	Control	4			
2	APG-02	4	2.0847	66.1	18.1150
3	APG-06	4	2.0847	66.1	20.0950
4	APG-16	4	2.0847	66.1	12.2600
5	APG-15	4	2.0847	66.1	21.9100

Toxstat Version 3.5 Page____of_____
Study # 60147216-445-(035-038)
ESTCP
Echinochloa crusgalli
Summary Statistics for Nutrient Uptake Factor: SULFUR using Lab Control

QA:CW 12\13\12
*12|13|12

Title: 60225262-445-(035-038)
File: 445sulf.dat Transform: NO TRANSFORMATION

Summary Statistics on Data TABLE 1 of 2

GRP	IDENTIFICATION	N	MIN	MAX	MEAN
1	Control	4	30.4000	44.9000	37.5750
2	APG-02	4	2.6100	6.4200	3.7625
3	APG-06	4	3.0100	5.5800	4.0300
4	APG-16	4	1.2800	1.3900	1.3400
5	APG-15	4	2.2700	4.1300	3.0900

Title: 60225262-445-(035-038)
File: 445sulf.dat Transform: NO TRANSFORMATION

Summary Statistics on Data TABLE 2 of 2

GRP	IDENTIFICATION	VARIANCE	SD	SEM	C.V. %
1	Control	41.8758	6.4712	3.2356	17.2220
2	APG-02	3.2128	1.7924	0.8962	47.6390
3	APG-06	1.1946	1.0930	0.5465	27.1210
4	APG-16	0.0025	0.0497	0.0248	3.7064
5	APG-15	0.8018	0.8954	0.4477	28.9784

Toxstat Version 3.5 Page____of_____
Study # 60147216-445-(035-038)
ESTCP
Echinochloa crusgalli
Analysis of Nutrient Uptake Factor: SULFUR using Lab Control

12|13|12
QA: cw 12|13|12

Title: 60225262-445-(035-038)
File: 445sulf.dat Transform: LOG BASE 10(Y)

Shapiro - Wilk's Test for Normality

D = 0.2000
W = 0.9248

Critical W = 0.8680 (alpha = 0.01 , N = 20)
W = 0.9050 (alpha = 0.05 , N = 20)

Data PASS normality test (alpha = 0.01). Continue analysis.

Title: 60225262-445-(035-038)
File: 445sulf.dat Transform: LOG BASE 10(Y)

Bartlett's Test for Homogeneity of Variance

Calculated B1 statistic = 10.0243 (p-value = 0.0400)

Data PASS B1 homogeneity test at 0.01 level. Continue analysis.

Critical B = 13.2767 (alpha = 0.01, df = 4)
= 9.4877 (alpha = 0.05, df = 4)

Toxstat Version 3.5 Page____of_____
Study # 60147216-445-(035-038)
ESTCP
Echinochloa crusgalli
Analysis of Nutrient Uptake Factor: SULFUR using Lab Control

QA: cw 12/13/12
12/13/12

Title: 60225262-445-(035-038)
File: 445sulf.dat Transform: LOG BASE 10(Y)

ANOVA Table

SOURCE	DF	SS	MS	F
Between	4	4.6549	1.1637	87.2704
Within (Error)	15	0.2000	0.0133	
Total	19	4.8549		

(p-value = 0.0000)

Critical F = 4.8932 (alpha = 0.01, df = 4,15)
= 3.0556 (alpha = 0.05, df = 4,15)

Since F > Critical F REJECT Ho: All equal (alpha = 0.05)

Title: 60225262-445-(035-038)
File: 445sulf.dat Transform: LOG BASE 10(Y)

Dunnett's Test - TABLE 1 OF 2 Ho:Control=Treatment

GROUP	IDENTIFICATION	TRANSFORMED MEAN	MEAN CALCULATED IN ORIGINAL UNITS	TRANS T STAT	SIG 0.05
1	Control	1.5700	37.5750		
2	APG-02	0.5446	3.7625	12.5575	*
3	APG-06	0.5942	4.0300	11.9507	*
4	APG-16	0.1269	1.3400	17.6737	*
5	APG-15	0.4762	3.0900	13.3957	*

Dunnett critical value = 2.7300 (2 Tailed, alpha = 0.05, df = 4,15)

Title: 60225262-445-(035-038)
File: 445sulf.dat Transform: LOG BASE 10(Y)

Dunnett's Test - TABLE 2 OF 2 Ho:Control=Treatment

GROUP	IDENTIFICATION	NUM OF REPS	MIN SIG DIFF (IN ORIG. UNITS)	% OF CONTROL	DIFFERENCE FROM CONTROL
1	Control	4			
2	APG-02	4	14.9161	40.1	33.8125
3	APG-06	4	14.9161	40.1	33.5450
4	APG-16	4	14.9161	40.1	36.2350
5	APG-15	4	14.9161	40.1	34.4850

Toxstat Version 3.5 Page____of_____
Study #60147216-445-(035-038)
ESTCP
Echinochloa crusgalli
Summary Statistics for Nutrient Uptake Factor: ZINC using Lab Control

12/13/12
QA:CU 12/13/12

Title: 60225262-445-(035-038)
File: 445zin.dat Transform: NO TRANSFORMATION

Summary Statistics on Data TABLE 1 of 2

GRP	IDENTIFICATION	N	MIN	MAX	MEAN
1	Control	4	8.0600	12.5000	10.6650
2	APG-02	4	0.3850	2.0900	0.8618
3	APG-06	4	0.1740	0.4210	0.3230
4	APG-16	4	0.0840	0.2240	0.1630
5	APG-15	4	0.0540	0.1520	0.1125

Title: 60225262-445-(035-038)
File: 445zin.dat Transform: NO TRANSFORMATION

Summary Statistics on Data TABLE 2 of 2

GRP	IDENTIFICATION	VARIANCE	SD	SEM	C.V. %
1	Control	3.4982	1.8704	0.9352	17.5373
2	APG-02	0.6728	0.8202	0.4101	95.1804
3	APG-06	0.0110	0.1051	0.0525	32.5249
4	APG-16	0.0035	0.0588	0.0294	36.0626
5	APG-15	0.0021	0.0455	0.0228	40.4778

Toxstat Version 3.5 Page____of_____
Study #60147216-445-(035-038)
ESTCP
Echinochloa crusgalli
Summary Statistics for Nutrient Uptake Factor: ZINC using Lab Control

12/13/12
QA: CU 12/18/12

Title: 60225262-445-(035-038)
File: 445zin.dat Transform: LOG BASE 10(Y)

Shapiro - Wilk's Test for Normality

D = 0.6776
W = 0.9282

Critical W = 0.8680 (alpha = 0.01 , N = 20)
W = 0.9050 (alpha = 0.05 , N = 20)

Data PASS normality test (alpha = 0.01). Continue analysis.

Title: 60225262-445-(035-038)
File: 445zin.dat Transform: LOG BASE 10(Y)

Bartlett's Test for Homogeneity of Variance

Calculated B1 statistic = 4.7217 (p-value = 0.3171)

Data PASS B1 homogeneity test at 0.01 level. Continue analysis.

Critical B = 13.2767 (alpha = 0.01, df = 4)
= 9.4877 (alpha = 0.05, df = 4)

Toxstat Version 3.5 Page____of_____
Study #60147216-445-(035-038)
ESTCP
Echinochloa crusgalli
Summary Statistics for Nutrient Uptake Factor: ZINC using Lab Control

JB 12/13/12
QA: CW 12/13/12

Title: 60225262-445-(035-038)
File: 445zin.dat Transform: LOG BASE 10(Y)

ANOVA Table

SOURCE	DF	SS	MS	F
Between	4	10.1516	2.5379	56.1813
Within (Error)	15	0.6776	0.0452	
Total	19	10.8293		

(p-value = 0.0000)

Critical F = 4.8932 (alpha = 0.01, df = 4,15)
= 3.0556 (alpha = 0.05, df = 4,15)

Since F > Critical F REJECT Ho: All equal (alpha = 0.05)

Title: 60225262-445-(035-038)
File: 445zin.dat Transform: LOG BASE 10(Y)

Dunnett's Test - TABLE 1 OF 2 Ho:Control=Treatment

GROUP	IDENTIFICATION	TRANSFORMED MEAN	MEAN CALCULATED IN ORIGINAL UNITS	TRANS T STAT	SIG 0.05
1	Control	1.0225	10.6650		
2	APG-02	-0.1803	0.8618	8.0029	*
3	APG-06	-0.5127	0.3230	10.2147	*
4	APG-16	-0.8140	0.1630	12.2199	*
5	APG-15	-0.9822	0.1125	13.3387	*

Dunnett critical value = 2.7300 (2 Tailed, alpha = 0.05, df = 4,15)

Title: 60225262-445-(035-038)
File: 445zin.dat Transform: LOG BASE 10(Y)

Dunnett's Test - TABLE 2 OF 2 Ho:Control=Treatment

GROUP	IDENTIFICATION	NUM OF REPS	MIN SIG DIFF (IN ORIG. UNITS)	% OF CONTROL	DIFFERENCE FROM CONTROL
1	Control	4			
2	APG-02	4	6.4367	61.1	9.8033
3	APG-06	4	6.4367	61.1	10.3420
4	APG-16	4	6.4367	61.1	10.5020
5	APG-15	4	6.4367	61.1	10.5525

Toxstat Version 3.5 Page____of____
Study # 60147216-445-(035-038)
ESTCP
Echinochloa crusgalli ✱12/13/12
Summary Statistics for Nutrient Uptake Factor: NITROGEN using Lab Control GA:CW 12/13/12

Title: 60225262-445-(035-038)
File: 445nitr.dat Transform: NO TRANSFORMATION

Summary Statistics on Data TABLE 1 of 2

GRP	IDENTIFICATION	N	MIN	MAX	MEAN
1	Control	4	13.8000	17.5000	15.5250
2	APG-02	4	0.6380	0.7640	0.6912
3	APG-06	4	2.1400	2.3400	2.2425
4	APG-16	4	0.9600	1.1300	1.0650
5	APG-15	4	0.8380	0.9630	0.9128

Title: 60225262-445-(035-038)
File: 445nitr.dat Transform: NO TRANSFORMATION

Summary Statistics on Data TABLE 2 of 2

GRP	IDENTIFICATION	VARIANCE	SD	SEM	C.V. %
1	Control	2.3092	1.5196	0.7598	9.7880
2	APG-02	0.0033	0.0572	0.0286	8.2813
3	APG-06	0.0068	0.0826	0.0413	3.6840
4	APG-16	0.0055	0.0742	0.0371	6.9636
5	APG-15	0.0028	0.0530	0.0265	5.8017

Toxstat Version 3.5 Page____of____
Study # 60147216-445-(035-038)
ESTCP
Echinochloa crusgalli
Analysis of Nutrient Uptake Factor: NITROGEN using Lab Control

dk 12/13/12
QA:CW 12/13/12

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Title:  60225262-445-(035-038)
File:       445nitr.dat              Transform:              LOG BASE 10(Y)

                  Shapiro - Wilk's Test for Normality
---------------------------------------------------------------------------

     D =    0.0148
     W =    0.9698

     Critical W  = 0.8680 (alpha = 0.01 , N = 20)
              W  = 0.9050 (alpha = 0.05 , N = 20)

---------------------------------------------------------------------------

Data PASS normality test (alpha = 0.01). Continue analysis.


Title:  60225262-445-(035-038)
File:       445nitr.dat              Transform:              LOG BASE 10(Y)

               Bartlett's Test for Homogeneity of Variance
---------------------------------------------------------------------------

Calculated B1 statistic =  2.4492              (p-value = 0.6538)

Data PASS B1 homogeneity test at 0.01 level. Continue analysis.
---------------------------------------------------------------------------

Critical B = 13.2767  (alpha = 0.01, df =  4)
           =  9.4877  (alpha = 0.05, df =  4)
```

Toxstat Version 3.5 Page____of____
Study # 60147216-445-(035-038)
ESTCP
Echinochloa crusgalli
Analysis of Nutrient Uptake Factor: NITROGEN using Lab Control

12/13/12
QA: 12/13/12

Title: 60225262-445-(035-038)
File: 445nitr.dat Transform: LOG BASE 10(Y)

ANOVA Table

SOURCE	DF	SS	MS	F
Between	4	4.7742	1.1936	1209.9408
Within (Error)	15	0.0148	0.0010	
Total	19	4.7890		

(p-value = 0.0000)

Critical F = 4.8932 (alpha = 0.01, df = 4,15)
= 3.0556 (alpha = 0.05, df = 4,15)

Since F > Critical F ~~REJECT~~ Ho: All equal (alpha = 0.05)

Title: 60225262-445-(035-038)
File: 445nitr.dat Transform: LOG BASE 10(Y)

Dunnett's Test - TABLE 1 OF 2 Ho:Control=Treatment

GROUP	IDENTIFICATION	TRANSFORMED MEAN	MEAN CALCULATED IN ORIGINAL UNITS	TRANS T STAT	SIG 0.05
1	Control	1.1895	15.5250		
2	APG-02	-0.1615	0.6912	60.8295	*
3	APG-06	0.3505	2.2425	37.7766	*
4	APG-16	0.0265	1.0650	52.3645	*
5	APG-15	-0.0402	0.9128	55.3698	*

Dunnett critical value = 2.7300 (2 Tailed, alpha = 0.05, df = 4,15)

Title: 60225262-445-(035-038)
File: 445nitr.dat Transform: LOG BASE 10(Y)

Dunnett's Test - TABLE 2 OF 2 Ho:Control=Treatment

GROUP	IDENTIFICATION	NUM OF REPS	MIN SIG DIFF (IN ORIG. UNITS)	% OF CONTROL	DIFFERENCE FROM CONTROL
1	Control	4			
2	APG-02	4	2.0157	13.0	14.8338
3	APG-06	4	2.0157	13.0	13.2825
4	APG-16	4	2.0157	13.0	14.4600
5	APG-15	4	2.0157	13.0	14.6123

Appendix H: Soil Density and Activated Carbon Application Rate Calculations

Soil Density and Activated Carbon Application Rate

The mass of soil in a unit volume is calculated using equation 1:

$$M = V * \rho_B \qquad (1)$$

Where M is mass, V is volume, and ρ_B is the bulk density of the soil. For wetland applications, the density of the soil is not directly known. The volume is determined by the size of the plot, and by the desired depth of the amendment. Based on previous studies, the biota layer where the amendment will be mixed is restricted to the top six inches of the soil. The chosen unit volume is one square meter by 0.15 m, or 150,000 cm^3.

For the field demonstration site, density and porosity was not measured directly. The only physical measurement conducted by the lab was the percent solids of the samples taken in July 2009. The average soil density on a weight basis was 33.8%. An effective density and porosity can be estimated from this information and average specific gravities. The soils at the site are described as mineral soils, with low total organic carbons. Mineral specific gravities range from 2.3 to 2.9 (Lambe 1969). Percent solids in a saturated sample can be expressed by the Equation 2.

$$S_{\%} = \frac{M_{solids}}{M_{solids}+M_{water}} = \frac{(1-n)V\rho_S}{V(1-n)\rho_S+Vn\rho_W} = \frac{(1-n)\rho_S}{(1-n)\rho_S+n\rho_W} \qquad (2)$$

Where M is the mass of the solids and water in a sample, V is the volume of the sample, ρ_s and ρ_w are the specific gravity of the solids and the water, and n is the porosity of the sample. Equation 3 is the result of solving Equation 2 for porosity in terms of density and solids percentage.

$$n = \frac{(1-S_{\%})\rho_S}{(1-S_{\%})\rho_S+S_{\%}\rho_W} \qquad (3)$$

The density of water is assumed to be 1 gram per cubic centimeter. The average percentage of solids in the samples taken from the site is equal to 33.8 %. Using an assumed ρ_s, the porosity, bulk density, and amount of activated carbon needed per square meter was calculated. Bulk density is calculated using Equation 4:

$$\rho_B = (1-n)\rho_s \qquad (4)$$

Table A shows the results of this analysis, where column 1 is assumed, column 2 is calculated using equation 2, column three is calculated using equation 4, and column 4 is calculated using equation 1. From the Treatability Study, the desired amendment ratio is 3% by weight, so column 5 is 3% of column 4.

Table A: AC Calculations

ρ_s	n	ρ_B	M_{solids}	AC Needed (kg/m^2)
2.9	0.9	0.4	65.1	2.0
2.8	0.8	0.4	64.8	1.9
2.7	0.8	0.4	64.4	1.9
2.6	0.8	0.4	64.0	1.9
2.5	0.8	0.4	63.6	1.9
2.4	0.8	0.4	63.2	1.9
2.3	0.8	0.4	62.7	1.9

It is unlikely that the mineral specific gravity is as high as 2.9 g/cm^3. As can be seen from Table A, for the likely range of mineral densities, the amount of activated carbon needed is 1.9 kg/m^2.

Appendix I: Points of Contact

Point of Contact	Organization	Phone/Fax/Email	Role in Project
Dr. Nancy Ruiz	NAVFAC EXWC 1100 23rd Avenue, Port Hueneme, CA 93043	(805) 982-1155 (805) 982-4304 (fax)	Principal Investigator, DoD project manager
John Bleiler	AECOM Environment 250 Apollo Drive, Chelmsford, MA 01886	(978) 589-3056 (978) 589-3100 (fax)	Contracted project manager and technical lead
Dr. Kevin Gardner, P.E.	University of New Hampshire 35 Colovos Rd, Durham, NH 03824	(606) 862-4334 (603) 862-3957 (fax)	Technical lead, amendment selection
Dr. Mark Johnson	USACHPPM 158 Blackhawk Rd. Aberdeen Proving Ground, MD 21010	(410) 436-5081	Technical lead
Dr. Trudy Estes	ERDC EP-E 3909 Halls Ferry Rd, Vicksburg, MS 39180	(601) 643-2125	Technical lead
Dr. Doris Anders	97 CES/CEAN 401 L Ave, Bldg 358 Altus AFB OK 73523-5138	(580) 481-7346	AFCEE technical lead
David Barclift	NAVFAC LANT c/o Navy PMO Northeast, 4911 South Broad Str., Bldg 679, PNBC, Philadelphia, PA 19112	(215) 814-3341	Technical lead